MANUFACTURED HOUSING IN RESOURCE COMMUNITIES

A NEW APPROACH

with funding provided by

Alberta

DEPARTMENT OF HOUSING

Innovative Housing Grants Program

MANUFACTURED HOUSING IN RESOURCE COMMUNITIES

A NEW APPROACH

January, 1984

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The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of the Alberta Department of Housing.

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FOREWORD

This study was made possible with funding provided by the Innovative Housing Grants Program of the Alberta Department of Housing. Originally conceived in 1978, the Program is intended to encourage, sponsor, and assist research and development in the fields of housing, site and subdivision design, energy conservation, site servicing and urban development. Generally, the aims of research funded by the Innovative Housing Grants Program are to reduce housing costs, increase the supply of appropriate housing or improve the utility or performance of dwelling units or subdivisions.

The main purpose of funding these studies is to examine the current issues in the field of housing and to develop innovations which offer improvements. Comments and suggestions regarding the information contained in these reports are welcome.

Innovative ideas come from a wide variety of applicants such as builders, developers, consulting firms, industry associations, municipal governments, educational institutions, non-profit groups and individuals. As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied.

Please send comments and suggestions or requests for further information to:

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SUMMARY

THE USE OF MANUFACTURED HOUSING IN RESOURCE COMMUNITIES

The problem of housing in resource communities became apparent with the tremendous growth of extraction and processing industries in remote areas in the past two decades.

As the volume and technical sophistication of resource extraction increases, larger permanent labour forces are required on site. One of the necessary conditions of maintaining a stable labour force is the supply of appropriate housing for employees and their families. The importance of this has been confirmed by social planning studies undertaken in resource communities. (Larsen, 1979; Praxis, 1982).

This study has examined two major housing forms, affordable single family units and on-site (camp) accommodation. The need for family housing is obvious in encouraging the development of long-term commitment to a resource community and consequently lower turnover of employees. Camp accommodation, though used for many years for temporary housing, has been the subject of review for many resource companies. New resource sites, accessible from existing towns, but outside a reasonable daily commuting distance, present the need for a review of alternatives to establishing a permanent town site. Permanent camp accommodation is one alternative to daily travel.

The resource companies who have acted as informed users in this study have capsulized the problem as:

1. the need for affordable housing that is within the income levels of the average employee,

2. housing that is privately-built without the necessity for mortgage assistance or other subsidy by the resource company,

3. housing that can be integrated within existing communities to avoid the stigma of company ghettos,

4. providing employment for the indigenous labour force of the affected communities and avoiding the economic upheaval of importing large labour forces from outside the area,

5. spreading the "regional benefits" of resource development over a larger area of the province.

The solution presented in this report is to integrate factory-built housing modules with transportation, site assembly and site finishing. This system presents an opportunity for cost-saving well known in the United States by removing many of the labour intensive components of construction to a controlled environment. Further, it offers sufficient on-site construction work to employ local semi-skilled labour.

The traditional mobile home is not unknown in the resource community. Both industrial and single-family home manufacturers have played a large role in providing accommodation especially in early stages of settlement. For families, this alternative is less expensive and more quickly obtained than a site-built home. For resource companies, industrial trailers offer mobility and limited capital investment for temporary employees.

These initial advantages tend to disappear as a community becomes more established. Mobile homes become a smaller percentage of total housing units as a community becomes more established.

A major reason for this decrease is related to the visual image of the mobile home. The traditional dimensions, roof lines, finishes, and lack of control over owner-built additions has generally emphasized the temporary nature of these dwellings. Surveys, completed in the early seventies, have shown that mobile home occupants are perceived as a poorly educated low-income group - a serious misconception.

The industry itself has suffered from the inability to integrate the marketing and delivery system of their product. A wide range of models are produced but the alternatives fail to deal with the most restricting constraints of dimensions; 14 or 16 foot width and roof pitch of 3:12 or 4:12. Although double-wide units have been available for a number of years, they offer no price advantage over site-built homes in most areas.

The vertical segregation of the manufacturing industry itself is in part responsible for a product that is not sufficiently price competitive with site-built housing to maintain a large market share. Each participant in the industry, including the dealers, manufacturing plants, and transporters act in an independent fashion. The buyer must pay a premium for co-ordination of these actors with little gain in choice of unit aesthetics, layout or design.

A study completed in 1982 (Reed Management) emphasizes the cost-saving available to manufacturers through:

1. shorter construction time;

2. greater quality control through the concentration of supervision on the plant floor and

3. superior systems of labour and material management.

These advantages and a more marketable housing unit are available if a rational means of integrating factory and site construction is introduced using contract documents that clearly identify the contractual responsibility of each party. If this control is introduced, other actors in the housing industry can be persuaded to use this cost-effective means of production. Access to a larger market, greater knowledge of consumer preference and management techniques suited to subdivision development would be of great benefit to the industry.

Resource communities were chosen as a target market for this innovative approach for the following reasons:

1. The remote location of most resource towns is partially responsible for higher housing costs. The premium arises from higher costs of imported materials and a less competitive market for skilled labour.

2. Home ownership is the ideal of 90 percent of resource community residents. (Praxis, 1982).

3. The desire to lower housing costs by participating in construction is present in the resource community market and can be integrated into this type of construction.(Praxis, 1982).

4. The size of the market is concentrated in locations affording an economy of scale sufficient to lower transportation and site installation costs.

Single-family Accommodation

The residents of resource communities form a unique market to the residential developer. The importance of finding means to reduce the cost of single family housing is apparent. Historically, company housing or mortgage subsidization has taken place to encourage employers to relocate to remote areas. The financial burden of this position is a major disadvantage to the company in soft markets when employees are unable to maintain their financial commitments for the accommodation.

The units presented here are intended for purchase by the employee without the need for direct company subsidization.

Camp Accommodation

Resource companies have, in this uncertain market for their product, become more conscious of their capital investment in employee accommodation. Alternatives of maintaining a labour force at locations outside a one hour commuting distance from established townsites are being explored. One of these alternatives is permanent on-site accommodation for employees on a twelve hour, four-day shift.

The quality of life in this type of accommodation is important. Studies completed in the 1960's in remote camps point to the importance of a wide range of social and recreational activities as a deterent to aberrant behavior. The ideal accommodation would be similar to a resort hotel, with provisions for visiting families and limited public use in periods of low company use. These hotels would be owned and operated by independent companies, relieving the resource company of management and control. Guarantees for leasing of rooms would be established in the development agreement.

The initial reaction among the key informants to the concept was positive. Resource companies, labour unions, hotel management firms and representatives of existing towns in resource areas feel this alternative is viable assuming that options are made available to suit the particular location and/or company.

Contract Documentation and Management

The initial portion of the research indicated that housing manufacturers feel their limitations in the market place are related to lack of development capital. Further exploration of this problem by Reed Management (1982) and this study team pointed out the industry's resistance to integration of their production process with conventional builders to achieve a more cost competitive and marketable product. Historically the attempts to use manufactured products in site construction has presented a number of problems. The most evident is lack of clear indication of the responsibility of each party in the contract documents. Dimensional control is poor or completely absent, site construction is not clearly separated from factory work, and mechanical and electrical contracts are vague. As examples, these problems illustrate the need for contract documents specific to the integration of factory and site construction.

The documents proposed make use of multiple overlays. Composed in a single sheet the finished product is illustrated. Each overlay specifies the work of individual contractor, factory or site. To further clarify the system, colour can be introduced into the contract documents to indicate the work of sub-contractors and/or points of particular concern.

These documents may be employed within any of the traditional systems of contract management; design-build, project management or the traditional tender. At the outset of the project, the design-build procedure appeared to hold the greatest appeal to resource companies minimizing their involvement in housing. As the research proceeded, it became apparent that other management techniques might be considered depending on the project.

Unit Costs

The sample contract documents prepared for this study were submitted to housing manufacturers and site contractors for cost estimates. The information provided revealed two important findings:

1. The cost of single-family housing could be reduced by as much as fourteen percent in remote areas with as few as twelve units. Greater cost savings are expected with larger projects.

2. In the study case, the proposed camp accommodation was estimated to cost more when built in the factory than on-site. This aberration was illustrative of the historical difficulties that have arisen between industrial camp manufacturers and site contractors in co-ordination of the

work. A discussion of the problem is described more completely on the document.

There are some significant differences in the approach of the industrial manufacturer and the single-family mobile home manufacturer. The former employs unionized labour in the factory, must incorporate more complex engineering standards than are required in single family units and must consider the additional stress imposed on the units during transportation to sites located in extremely remote areas. On the other hand, these plants produce a greater volume and a more standardized module leading to the expectation of a lower per unit cost. An expectation that is not met.

The body of the report illustrates the potential cost-savings available to the buyer due to the length of production runs, the cost of assembly components, transportation modes and costs, unit erection costs and site servicing and utility connections. Some of these cost-savings are further enhanced by the design and contract documentation system proposed in this report.

Conclusions

The resource community presents a market area for manufacturers in single-family and on-site accommodation. In order to develop the potential that exists, manufacturers must re-examine their approach to design, marketing and liaison with site builders. Essentially, they must reconsider their contribution to the housing industry. As a product, the traditional manufactured unit will remain as a limited approach. As a process, the factory floor has limitless potential in reducing the cost of accommodation in remote areas.

Resource companies and their employees will benefit from reduced unit costs while maintaining an appropriate range of choice in design and aethetics. Manufacturers will benefit by increasing their market while maintaining a reasonable range of production efficiency in specific module production. Contract co-ordination with site builders is available, through documentation that clearly establishes the limits of each actor's participation and responsibility eliminating the need for cautious bidding or fear of contract battles during or after construction.

INTRODUCTION

BACKGROUND

This project was developed to explore the specific housing needs of resource companies in remote areas and to suggest a method of production that would reduce the cost of this housing.

The use of manufactured housing for resource areas is not a new idea. Industrial housing manufacturers have supplied temporary accommodation to resource companies for many years. The use of the traditional mobile home in remote communities for family housing has also been well established.

Manufactured housing responded well to these initial housing demands. It can be purchased, financed and erected much more quickly than a site built home. The capital investment of the buyer is lower and the unit does not require a permanent foundation. It offers more privacy than an attached house or apartment dwelling without a significant increase in cost.

While these advantages exist, the market for the traditional mobile home has undergone a drastic reduction. Resource communities have become more established and family accommodation with a more permanent image is in demand.

On-site camps operated by resource companies are also becoming permanent accommodation for operational staff. The attention to design quality has increased and employers are looking to greater innovation and flexibility in these permanent camps.

Demonstration projects in the United States have clearly presented the cost advantage of manufactured housing even on a single-design basis. (Malone, 1983) The units built resembled site-built housing rather than traditional mobile homes. This conformity will without doubt increase the acceptance of these units by bylaw enforcement agencies and the general public, encouraging the relaxation or adaptation of lot restrictions to account for the less-flexible unit dimensions of manufactured housing.

The most successful modular producers concentrate on multi-unit developments. In this regard longer runs of standard units can substantially lower the per-unit cost. (Jordan, 1983) The immediate advantages to the developer are:

1) lower cost of unit increases potential market;

2) faster construction times lower interim financing costs;

3) assembly by semi-skilled labour on site lowers over-all labour cost;

4) accelerated delivery time simplifies the financial arrangement for vendor and buyer.

(McLeister, 1982)

The developer brings his experience in land assembly, familiarity with large scale markets and lower overhead to assist the manufacturer whose largest concern is to maintain peak production and capital utilization of the plant.

OBJECTIVES

The specific objectives of this study are:

1) to identify the particular housing needs of resource companies in remote locations;

2) to provide appropriate designs using factory-built modules to meet these needs;

3) to suggest means of improving the co-ordination within the manufactured housing industry and between this industry and site contractors to achieve a superior form of accommodation; and

4) to identify the cost-savings available to resource companies and resource community residents using this system of co-ordination.

SCOPE

The study investigated new designs and means for procuring more appropriate and less costly accommodation for families living in resource communities. More specifically, it examined an approach which used manufactured units, which would be transported to and finished at the building site. The study also developed a system of contract documentation to improve the co-ordination of factory produced units with on-site construction

The study used representatives of resource companies and the manufactured housing industry as key informants to provide information.

ORGANIZATION

Chapter 1: describes the housing needs of resource community residents and the alternatives available to resource companies for camp housing.

Chapter 2: illustrates a design proposal responding to the requirements of Chapter 1.

Chapter 3: describes the contract documentation system proposed to co-ordinate site installation and finishing of factory units.

Chapter 4: provides cost estimates of the proposed accommodation.

Chapter 5: provides summary conclusions of the research.

CHAPTER 1 - HOUSING REQUIREMENTS IN RESOURCE COMMUNITIES

1.1 INTRODUCTION

A full discussion of the development of resource communities can be found in Praxis (1982) and Larson (1979). This discussion will become specific to its objective of proposing accommodation for these communities.

The economies of resource development have led companies to intensify the search for a housing policy that recognizes the resource company as an employer and not a housing developer or financing agent. Although the social responsibility of providing suitable accommodation is recognized as a cost of resource development, resource companies wish to reduce their long-term commitment to the housing market.

As a result, they have taken a significant interest in the development of a system of production for affordable accommodation. The potential of this system to offer housing that is economically attractive to their workforce without direct subsidization is extremely important.

1.2 SINGLE FAMILY ACCOMMODATION

The discussion will focus on three major concerns identified by Praxis, (1982), and confirmed by key informants who are studying resource development in Coal Valley and McLellan Lake. These concerns are cost, availability and suitability of housing for the labour force.

Price is a primary concern of any potential home buyer. The financial aspects: value, cost of financing, availability of downpayment, etc. are major determinants in a decision to purchase. In resource communities the assumed risk of investment and a higher purchase price add to the list of cost-related variables.

The barrier most commonly identified by resource community residents in obtaining housing was cost. Over 90% of residents preferred single family housing. Only 57% lived in a single family home. (Praxis, 1982) It is difficult to assess from the research what the expected cost of housing is, though the average unit was $90,000 to $100,000 and the average monthly cost was $525. In newer resource towns, such as Fort McMurray the costs were generally higher. The range of company accommodation benefits and their effect on monthly costs was not discussed but residents were theoretically willing to pay approximately 7% more to obtain more suitable accommodation. The aspects of suitability are discussed later in this section.

Resource companies and their employees are concerned with the cost of housing and the security of their investment. The relative cost of construction of new homes outside Edmonton increases from 7% (Red Deer, Alberta) to 23% (Fort McMurray, Alberta). (Hanscomb 1982) In the latter, this premium is attached first to labour cost (30% greater) and secondly to supply of materials (17% greater). The cost of labour dropped significantly from 1981 to 1982 as the housing market slumped suggesting the powerful influence of this component on cost in high-demand labour markets.

The discussion of value is closely tied to security of investment. The construction and sale of housing will respond to the availability of a market. In resource communities population increases are more erratic,

tied to the employment opportunities. Thus the purchase of a home in a boom involves a greater risk to the consumer, especially if a premium price is paid. This premium can be lost when employment drops, a time when security is most necessary.

It is apparent that resource companies recognize this risk and are willing to cushion, to some extent the premium cost of speculative home sales. In the past, this cushion has taken the form of interest-free loans, or subsidized mortgages. More recently, the attitude has begun to change. Paternalistic policies have created a burden when production has dropped. The resource companies, in looking for an arm's-length relationship are examining the potential of subsidizing development and construction of accommodation as an alternative to subsidizing individual employees in their purchase.

The cost of capital investment must reflect the expected life of the resource. This is the strongest argument against the construction of new towns dependent on a single industry or resource. Without the assurance of continued operation, the costs of infrastructure to support a residential community are a great risk.

The second issue concerning residents is the suitability of units. Praxis (1982) discusses the housing preferences of resource community residents in detail. For this report the following summary presents the characteristics of the desired accommodation.

Many people move to resource communities to improve their housing situation. As mentioned above almost 90% of residents desire single family housing. The five most important variables beyond cost in the decision to purchase are:

1. A medium to large lot (12.5 - 18.5 metre frontage),
2. A minimum of 112 square metres of living space,
3. Some choice in interior layout and individuality of the unit,
4. Privacy, and
5. Adequate insulation.

To balance the cost of these requirements, residents were willing to accept:

1. A lower level of interior finishing,
2. A minimum amount of landscaping, and
3. A reduced level of street servicing.

A number of specific variables appeared in the data that were related to regional climates, (amount of insulation, provision of a carport/garage) and life-cycle stage, (number of bedrooms, amount of storage). Some of these features can be provided by the residents

themselves if the cost of housing is reduced. This concept of 'sweat equity' is important in designing suitable accommodation. Unfinished space must be planned to accommodate living area finished by the owner at a later date.

The third concern of residents is availability of units. Population in resource communities does not increase with the regularity of more stable communities. Housing supply will reflect the demand but at a slower rate, leaving those who desire accommodation waiting for it to be built. Housing availability is an extremely important factor in reducing labour turnover, (Praxis, 1982).

The speed of development is clearly affected by the risk undertaken in speculative construction. The location of these communities and their dependence on single industries are important determinants for house builders. If a buyer cannot be assured, then the cost of construction will rise to reflect this uncertainty. This cost premium may reduce the size of the available market.

At least one resource company has suggested that single family housing could be pre-sold to employees prior to their move to the community. The viability of this approach would be strengthened by providing model homes erected at the hiring offices, allowing selection of the appropriate model and lot.

The provision of housing for resource company employees is a complex issue that will require a co-operative effort between the company, government agencies and home builders. The intention of this research is to demonstrate that the size of the market is sufficient to introduce factory-built housing units that can be quickly erected as the labour force arrives in the community. These units, erected on permanent foundations, are intended to expand the penetration of housing manufacturers into a more conventional single family market.

1.3 ON-SITE CAMP ACCOMMODATION

As part of a plan to maintain longer daily shifts and shorter work weeks, resource companies have considered the construction of permanent on-site camp accommodation. Integral to this housing form are minimum standards of quality necessary to encourage the co-operation of employees in the production efficiencies of longer shifts. Secondly and related is the company's desire to maintain an independence from managing the accommodation.

The quality of life in industrial camps in any remote location has traditionally been poor. Studies completed by social scientists in the late 1960's emphasize the restriction of activities as primary causes of aberrant behaviour. As a consequence, more diverse recreational opportunities are planned and accommodated in many remote camps.

The primary planning of on site accommodation must provide for employees on 12 hour shifts (shared units), employees on eight hour shifts (single units), and finally permanent accommodation for single employees (one-bedroom apartments). The unit design must accommodate

specific mixes as determined by the company and therefore maximum standardization of modules is desirable.

On-site building should include recreation and dining facilities. The type of facilities may vary according to the attitude of the labour force. Specific packages of alternatives will be suggested and a single one chosen.

The quality of the individual units may vary slightly according to the requirements of managing companies who will assume ownership and operation on the basis of minimum leasing agreements with the resource company.

This approach is highly innovative as it will require co-operation to assure the satisfaction of the resource companies, labour unions, property management firms and government agencies. Subsequent chapters will describe how a new form of accommodation might be used to maintain the economies of longer work shifts without the need for family accommodation at the resource site.

CHAPTER 2 - DESIGN PROPOSAL

2.1 CURRENT PRACTICE IN THE MANUFACTURED HOME INDUSTRY

The most obvious advantage of manufactured housing is the economy that can be obtained in line production. Most of the cost-savings resulting from these economies are lost by the self-imposed vertical segregation that exists in the industry at present. (Reed Management, 1982).

This problem influences and constrains design, quality control and limits the adaptability of the product to a wider market.

Unit design is limited most significantly by transportation. Although it is possible to construct a unit in the plant that is virtually indistinguishable from a site built house, the product must be transported to the lot. Width and height have long been identifiable characteristics of manufactured homes. The reluctance of manufacturers to become involved in more than limited site work, and without the contract documents to clearly establish factory, transportation and site responsibilities have meant that these restrictive dimensions prevail. An integrated system of building could expand the use of modular units as the basis for residential building with site-finishing clearly documented. The system would free the manufactured unit from these initial dimensional constraints on the height and width of the final unit.

Quality control is also influenced by vertical segregation. (Reed Management, 1982). Although the structural components of factory-produced units are designed to withstand the stress imposed in transportation, interior and exterior finishes are not. Many of the common interior finishes found in mobile homes have been chosen to counteract the potential damage; prefinished panels, for example, are installed instead of drywall. Although warranty call-backs are not excessive, there is often difficulty in establishing responsibility. As each party acts independently, the dissatisfied owner must deal with each operator to establish responsibility and gain satisfactory resolution of the complaint.

The estimated average cost of factory-built units in 1982 was $22 per square foot. The installed cost was $36 - $38 per square foot. Site-built housing in urban areas was $38 - $40 per square foot. The significant price advantage of factory production is lost in handling and finishing charges between the plant gate and the site. The size and variety of the product line is in part responsible for the initial factory costs. (Reed Management, 1982)

Present figures indicate that the cost of labour is only 19% of the total cost of the factory-built unit, whereas it is 28% of the cost of a site-built unit. This alone is a substantial cost-saving opportunity. The construction time in the factory averages 180 - 300 hours. Site construction averages 700 - 1000 hours. This difference could result in substantial savings in financing costs to developers.

Capital utilization of factories is currently low (Reed Management, 1982). Standardizing the present product for field finishing on minimum production runs is a potential solution to increasing production and could lower the per-unit cost. This standardization will only result from an integrated system based on turn-key proposals, incorporating the advice of qualified design and marketing experts who are able to predict and establish the market appeal necessary for bulk orders.

Discussions of this research with manufacturers revealed a surprising reluctance to incorporate the use of outside designers within the systems used in the plant. The use of the performance criteria established by the Canadian Standards Association, the limitations imposed by road transportation and dealer orders combine to become design criteria for the manufactured units.

2.2 AN ALTERNATIVE APPROACH FOR MANUFACTURED HOUSING

The potential marketing advantages of factory produced housing are:

1. shorter construction time,

2. greater quality control through management concentration on the plant floor,

3. superior systems of labour and materials management.

(Reed Management, 1982)

Factory production is not constrained by climate, can overcome problems of component delivery and storage found in on-site construction and can integrate production without the problems created by independent sub-trades.

The inherent advantages of factory production, combined with an integration with other actors in the housing industry who have access to land, knowledge of consumer markets, and proven ability in management is not a new idea. Developing the actual designs and systems to support this approach is an inherent requirement of its practical realization.

A component of this approach is contract documents that clearly outline the responsibilities of each participant in the system of production, delivery and finishing. Examples of these documents will be presented in Chapter 3.

The development of a more marketable unit and its introduction into geographical areas that are most severly affected by lack of indigenous skilled labour is an incentive for the developer to explore the market potential and financing package for developments of groups of factory produced units.

The effort made towards targeting the market more carefully, and sub-contracting finishing to the field could provide an opportunity to standardize factory production. This would lead to a greater economy of scale.

The joint-venture of a developer and manufacturer in securing land and providing units for a resource company brings the following benefits:

1. There is sufficient demand to achieve an economy of production, as the client minimum needs are unlikely to be below 10 units, thus ensuring a greater level of standardization and more intensive capital utilization.

2. The land component assures the developer of achieving a reasonable return for investment in land servicing, etc.

3. The client can provide specific information on the quantity and timing of demand, allowing an effective time management system in production.

4. A minimum number of units will allow the efficient use of field labour for foundation construction, set-up and unit finishing.

The resource company's desire to maintain a distance from housing development is apparent. The desire to provide quality accommodation without direct subsidization is considered an essential advantage in both single-family and camp accommodation.

Manufacturers in the industrial housing sector are less likely to respond positively to the proposal for camp accommodation. The lack of regulation in the present system of production has allowed these manufacturers to use short-term solutions amenable to temporary use of their product. Permanent use of the units has exposed the limited cost-effectiveness of finishes such as vinyl covered drywall or plant applied sheet flooring. Further, the temporary nature implied in "camp" accommodation has stifled the development of effective noise control or a more humane aesthetic. Introduction of design controls employing the factory building as a process is viewed with the suspicion that costs and administrative problems could increase without any direct benefit to the manufacturer.

2.3 CONSTRUCTION AND BUILDING REGULATIONS

2.3.1 SINGLE FAMILY UNITS

The Canadian Mobile Home and Travel Trailers Manufacturers with the Canadian Standards Association established a performance standard, CSA

Z 240 in 1971. The introduction and enforcement of this standard has improved the quality and safety of mobile homes. (Reed Management, 1982).

The introduction of new designs and the increase of mobile homes on permanent foundations prompted the introduction of CSA A 277 regulations. This latter code prescribes standards of products and construction processes rather than simply performance and conforms closely to the National Building Code accommodating the factory production methods.

The effect of this standard code (CSA A 277) has been a more rigid and durable product designed to specific regional variations in climate and provincial electrical and plumbing codes.

The use of manufactured homes in cities and towns in Alberta is restricted to land zoned for mobile homes. Lack of compliance to the Alberta Building Code acts as a barrier to erection on conventional lots. A major problem in this regard is the lack of regulation on temporary foundations and site built additions. CSA does not regulate the standard of construction beyond the plant gate.

In order for manufactured housing to compete with single-family housing, it is recommended that the National Building Code be adopted as the standard for production of homes on permanent foundations. This implies the need for continuity between factory and site work and thus the introduction of new development procedures. Problems that exist now on warranty call-backs would only be magnified if quality control is not monitored through to occupancy and beyond to include year-end inspections. These inspections would cover factory-work, on-site work, and the integration of both processes.

A major difficulty in meeting the National Building Code is the inspection procedure required of authorities having jurisdiction. This difficulty is exacerbated by the distance between the plant site and the building site. Manufactured housing plants are certified by application to the CSA. A plant is required to demonstrate it's quality on monthly inspections which are charged to the manufacturer. CSA labels are then affixed to the product. Local building authorities may not be familiar with these CSA guidelines and are therefore hesitant to approve structures according to Part 9 of the National Building Code.

The development of a specific section in Part 9 of the code may be required recognizing the transfer of approval from factory inspection to site inspection. The latter would specifically examine foundations, hook-ups and final finishing accepting the certified quality inspection of the pre-built unit by others.

Compliance with zoning regulations will depend on the local government's view of the units as mobile homes or as single-family homes.

Transportation of the units determines certain dimensional constraints for manufactured housing. These dimensions may restrict the siting of units on conventional single-family lots.

The land-use bylaw for the Town of Edson, the closest existing community to the Coal Valley operation of one key informant, was examined to confirm the compliance of the proposed units. Mobile homes are permitted as a discretionary use in districts zoned R-1. Minimum requirements for set-backs can be met with modifications to site-built portions of the unit.

Factory-built units and narrow lot designs may cause some concern in established residential neighbourhoods. It is expected that the flexibility of these units, especially in the opportunities available with site-finishing, conventional roof slopes and exterior finishes congruent with the existing neighbourhood character, will facilitate their acceptance as discretionary uses in existing single-family neighbourhoods.

2.3.2 ON-SITE ACCOMMODATION

Temporary accommodation for construction labour is subject to approval by the Camp Review Committee of the Alberta and North West Territories Building and Construction Trades Council and the Alberta Labour Relations Association. Although the provision of on-site accommodation for the resource industry labour force is not specifically subject to the Camp Review Committee. Their review is important in establishing a comparative quality standard for the unit designs developed in this phase.

2.3.2.1 CONSTRUCTION LABOUR RELATIONS ASSOCIATION

This organization provides the following guidelines for camp design and construction.

1. All camps are to be constructed and maintained by union labour.

2. Each resident will be provided with a single room, individually keyed, with an individual thermostat.

3. A minimum room size of 7.43 square meters with a minimum window area of 0.5 square meters is required.

4. Walls and floors must be finished wood or covered with an acceptable finish.

5. Each room must be provided with a lockable clothes closet of at least 600 mm depth and 750 mm width, a shelf to accommodate luggage, a drawer 600 x 375 x 250 mm, a single bed 1950 x 900 mm, a desk, a shelf and a mirror cabinet.

6. Corridors must be enclosed. Sound proofed floors with a non-slip finish covered by a vinyl runner are required.

7. All entries from exterior require air lock vestibules.

8. A heated laundry room will be provided for each 22 occupants.

9. Flush toilets are required for each 5 occupants up to 15 and for each 15 occupants thereafter. One urinal is required for each 25 occupants. Showers are required at the ratio of one to eleven persons.

10. Recreational space will be developed on the basis of 0.5 square meters of space per man in addition to a dining area.

11. Each camp will have a commissary.

These regulations clearly illustrate the use of existing manufactured units as a base standard. Though this is not necessarily a critical problem, the development of acceptable units in new forms may be subject to political evaluation as well as social and economic criteria.

The actual requirements meet the minimum standards of living accommodation as set forward by the National Building Code with few exceptions. Discussions with the key informants and colleagues in human resource consulting have led to the conclusion that temporary accommodation for resource company employees may be developed on a more comprehensive set of planning principles than recognized in the past.

2.4 THE UNITS

As a response to the information provided by the key informants two prototypical unit forms have been developed. The first are family units developed specifically for 30 foot lots but adaptable to lot sizes of up to 45 feet; secondly, standard units for use in permanent on-site accommodation. Each of these prototypes has been developed with variations to meet the range of situations expected by the resource companies who have assisted in development. See Figure 2: Unit Design following Page 11.

FAMILY ACCOMMODATION

The family unit is based on two modules of 12 feet and 14 feet that are transported to the site and placed on a basement foundation. Site finishing would include construction of the roof, (using standard trusses pre-built and shipped with the unit), exterior finishes and landscaping. The placement of a light well to the lower level would be completed on site.

The units were developed with three bedrooms, separate living and dining rooms and an exterior deck accessible from the interior only. The basement will provide an adequate storage area as well as additional area with an abundance of natural light suitable for finishing by the owner.

Interior finishing at the plant would proceed to the installation of drywall. Taping and sanding for prescribed finish or finishing by the owner has been designated as site construction due to the potential damage inflicted by transportation.

The units range in size from 112 square meters to 130 square meters, within the range suggested by the sample population.

The cost of the units will be verified in Chapter 4. Maintaining a consistent module is paramount to achieving the economy of scale required in lowering the cost of the manufactured units. Specific option packages could be offered to the consumer on purchase. These packages will offer the buyer individuality at varying costs.

In view of the image of these units, the primary design objective was to design a single family unit that overcame the image of a traditional mobile home without losing economy of factory production. The following floor plans and elevations in Figure 2 attest to the aesthetic success of that objective.

ON-SITE ACCOMMODATION

In instances where travel time and shift work become an economic premium for resource companies, and thrust greater social stress on workers' families alternate means of accommodation must be found. This configuration is in response to the need of workers who work shift work, 12 hours on and 12 hours off, and who work a four day week at plant sites not conveniently located to established communities, and serves the needs of employees for the duration of the four day work week. The worker's family would be located in an adjacent established community.

The accommodation is based upon a 14 foot by 26 foot module, and contains:

1. Complete full bathroom.
2. Individual lockable storage for two men.
3. 2 writing desks.
4. 2 - 3/4 size beds.
5. Sitting area.

Interior finishing in the plant would include all plumbing fixtures and ceramic tile, laminated drywall would be left unfinished so that taping and painting could proceed on site. Carpeted floor finishes would be factory installed and protected with a polyethylene film at the factory. Millwork items would be factory fabricated and installed.

The exterior finishes would be installed on site making the units adaptable to various factors, such as length of plant life, particular aesthetic requirements, or energy conservation criteria. Balconies, or other ammenities are to be site constructed.

FIGURE 2: DESIGN DRAWINGS

The following sketches illustrate the units designed for on-site accommodation.

There are three types of units in the on-site accommodation and three single family units.

SINGLE FAMILY HOUSING

Unit A Plan

Unit A Elevation

Unit B Plan

Unit B Elevation

Unit C Plan

Unit C Elevation

ON-SITE ACCOMMODATION

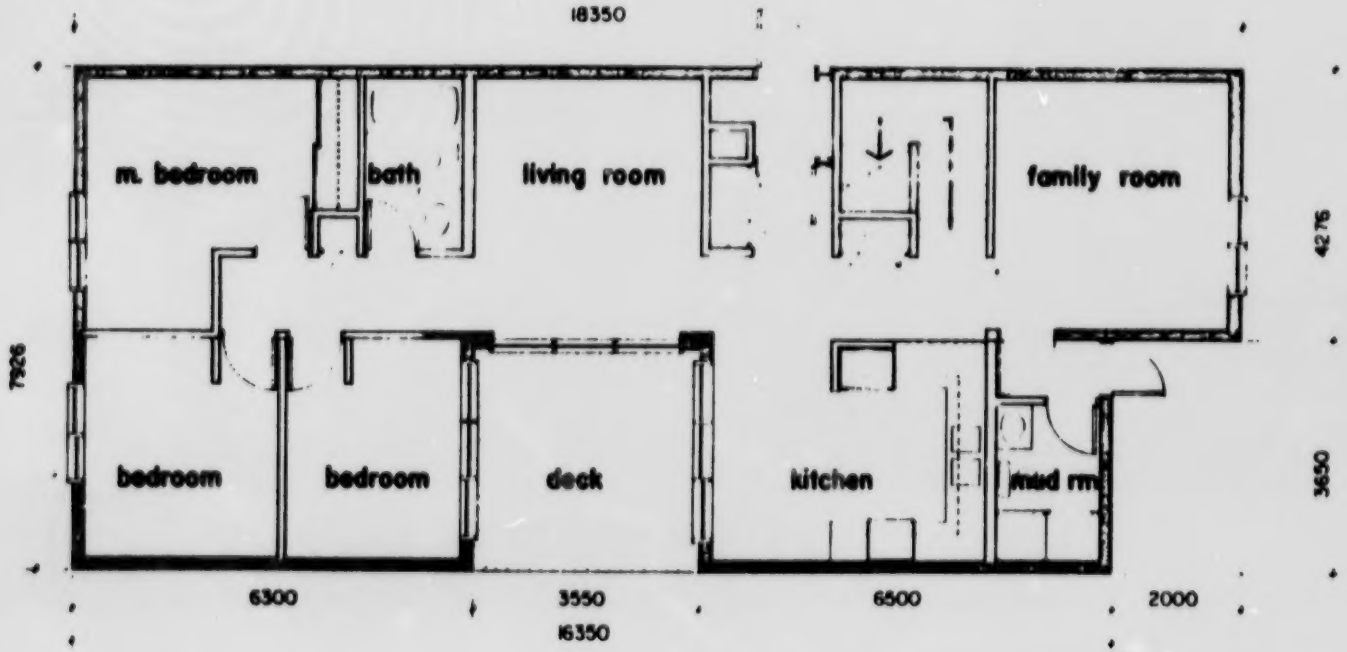
Elevation C-4

Single Unit

Shared Unit

Apartment Unit R

Apartment Unit L



module A-12, and module A-14 combine to form unit A

note stair to basement shown for clarity, as site-built item see sheet 10 volume 2

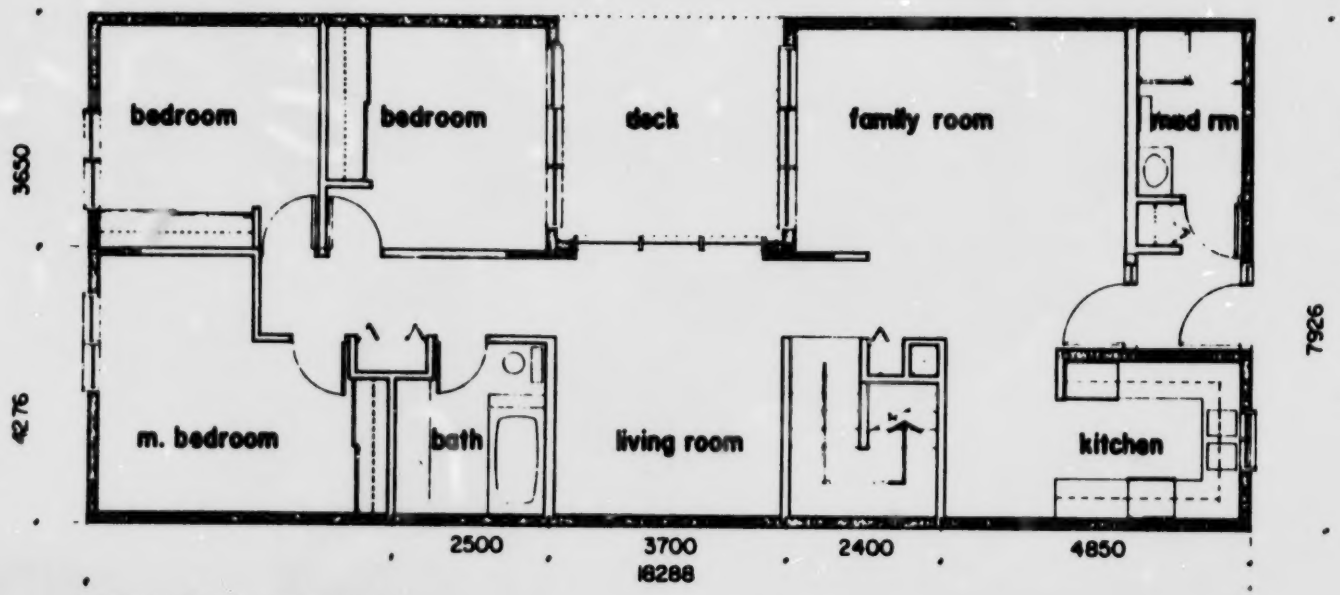
MODULE LOCATION PLAN UNIT •A•

VOLUME 1 SHEET 7

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

gary c frost

side elevation
front elevation
UNIT •A•
VOLUME 2
SHEET 16
SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES
gary c frost architect ltd



module B-12, and module B-14 combine to form unit B

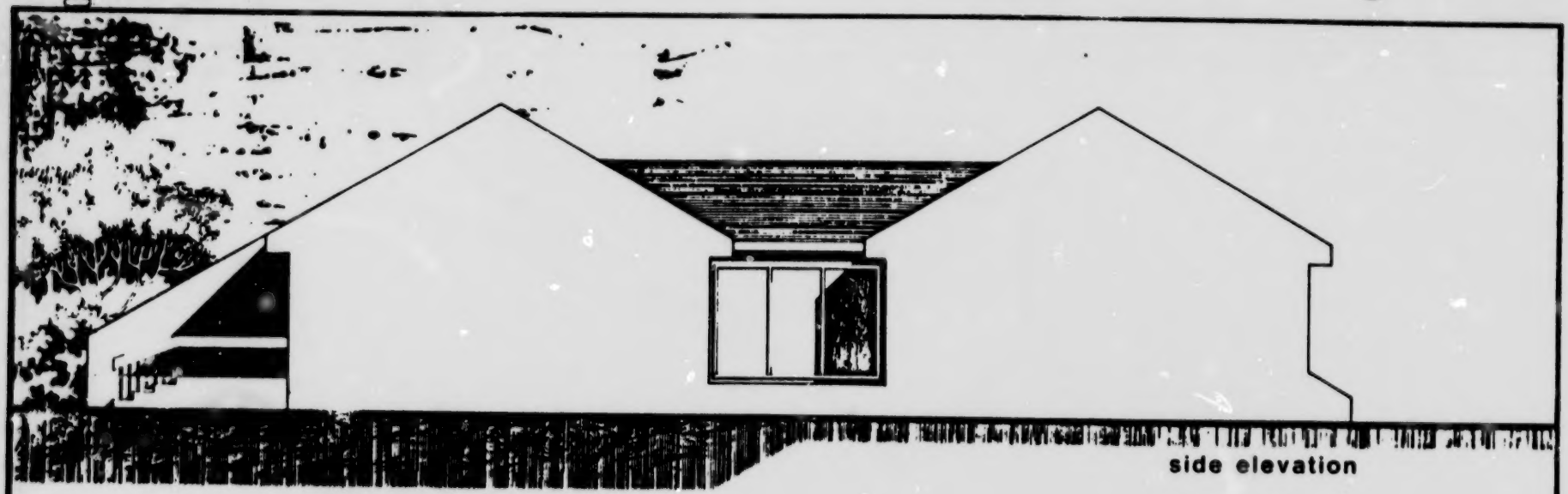
note stair to basement show for clarity, as site-built item see sheet 11 volume 2

62 MODULE LOCATION PLAN UNIT • B

VOLUME 1 SHEET 8

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

c frost



side elevation

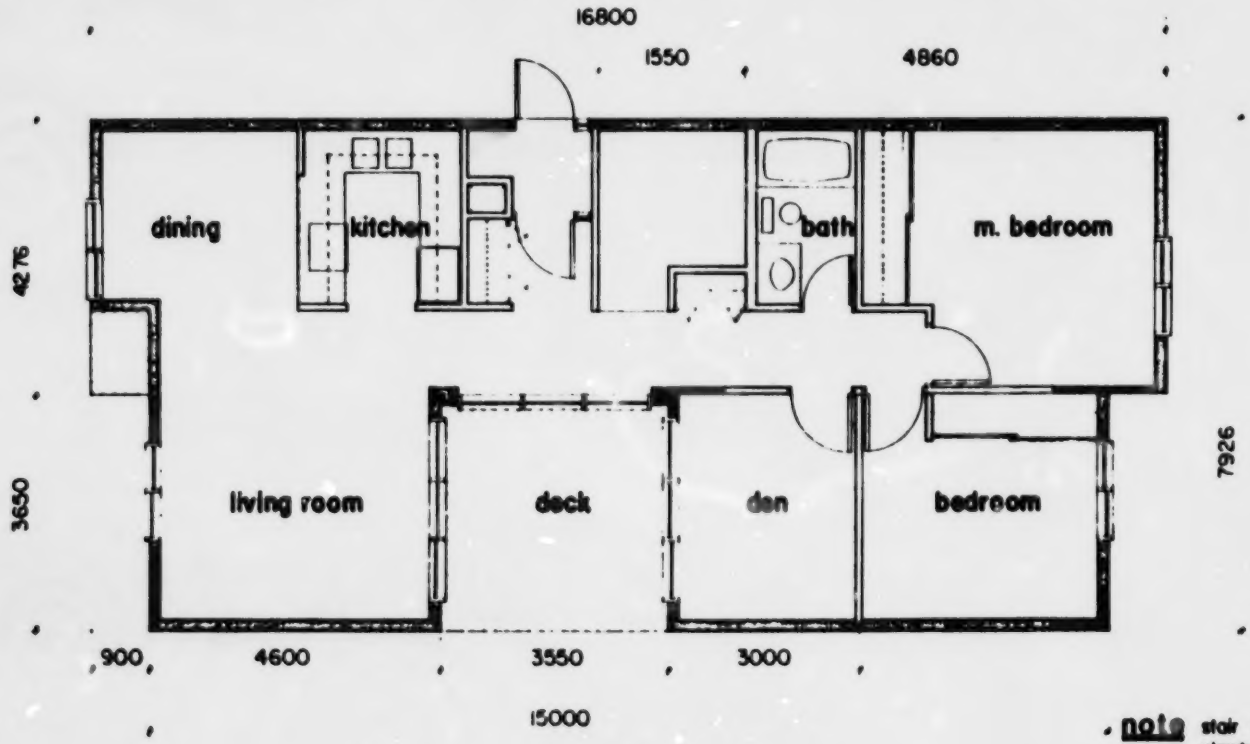
front elevation

UNIT •B•

VOLUME 2 SHEET 17

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

carry c frost architect ltd



note stair to basement shown for clarity, as site-built item see sheet 12 volume 2

module C-12, and module C-14 combine to form unit C

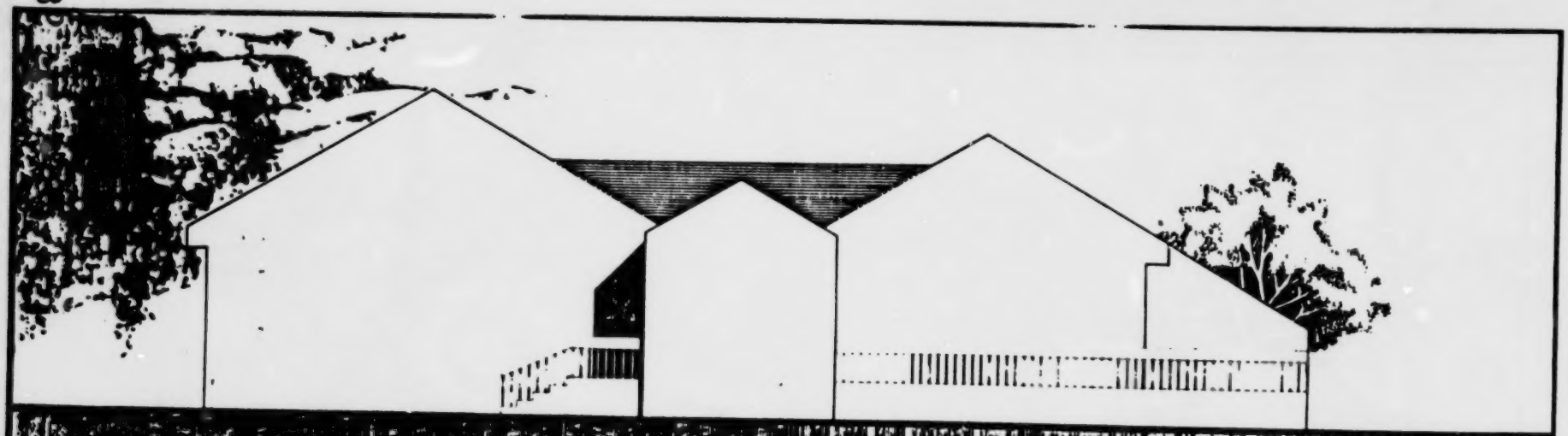
31

MODULE LOCATION PLAN UNIT • C

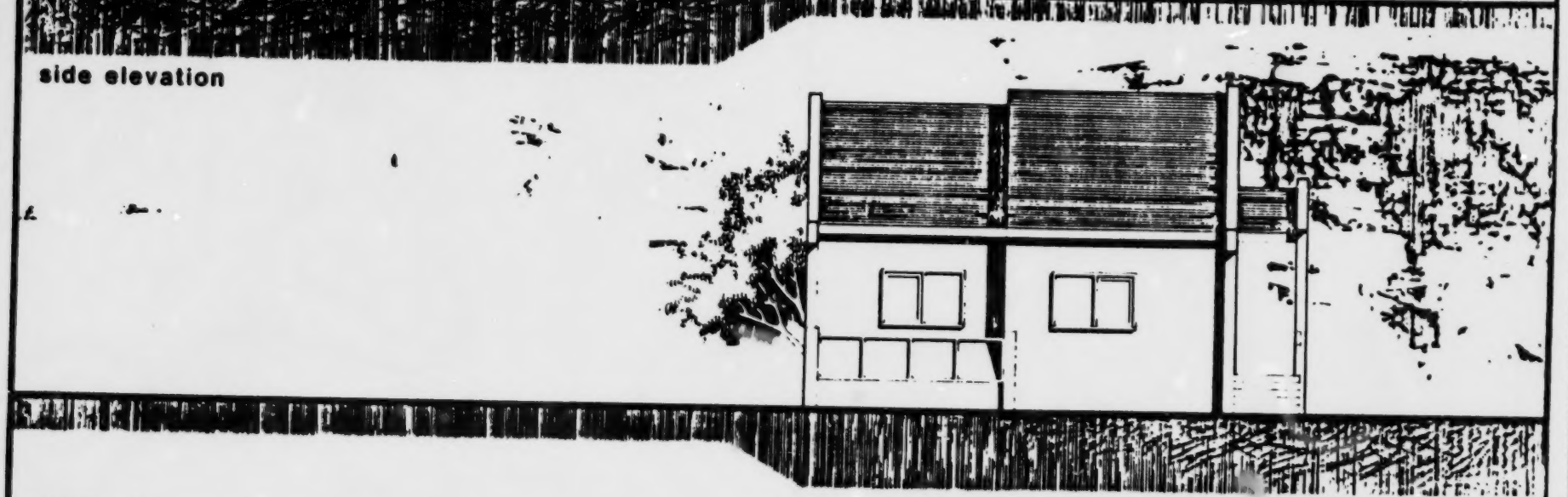
VOLUME 1 SHEET 9

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

gary c frost architect ltd



side elevation



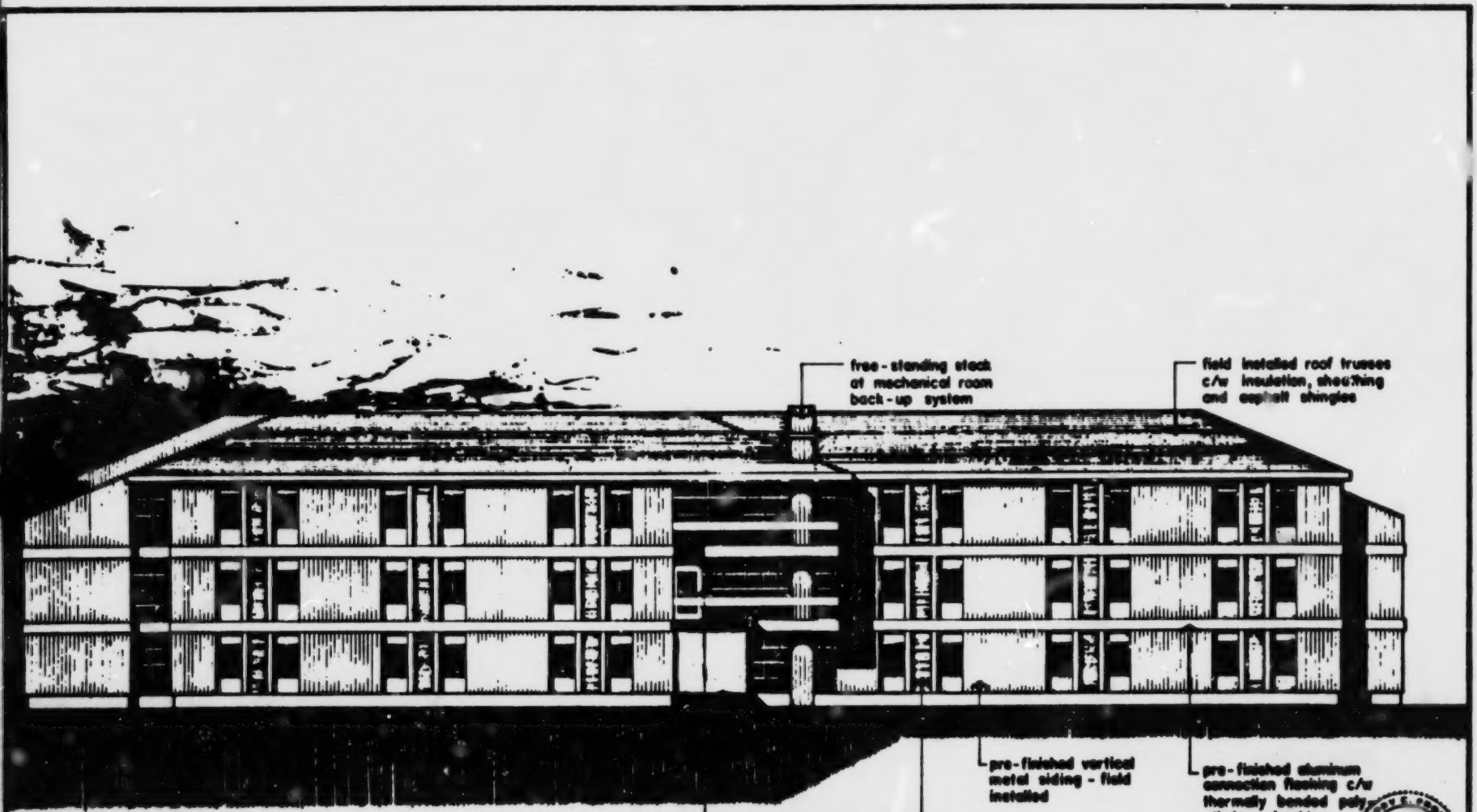
UNIT •C•

front elevation

VOLUME 2 SHEET 18

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

barry c frost architect ltd

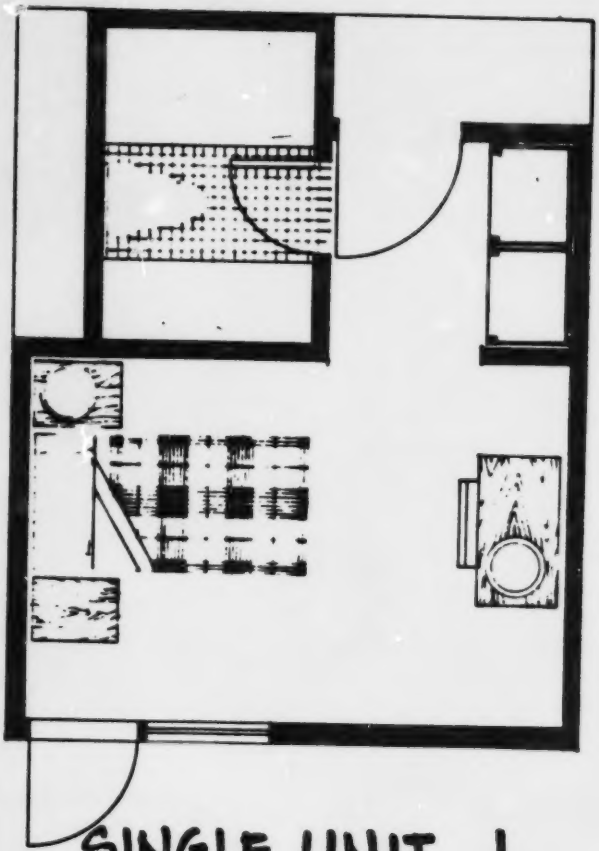

free-standing stack at mechanical room back-up system
field installed roof trusses c/w insulation, sheathing and asphalt shingles
pre-finished vertical metal siding - field installed
pre-finished aluminum connection flashing c/w thermally bonded poly ethylene backing
field installed curtain wall glazing at laundry room, mechanical room
pre-finished horizontal metal siding - field installed

EAST ELEVATION · 1:100 (alternate)

VOLUME C/4 SHEET

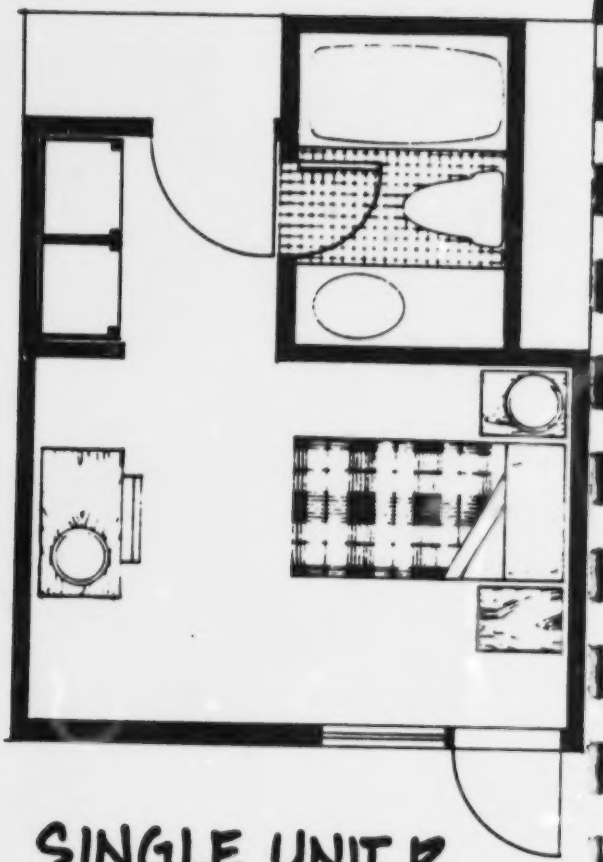
WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)



SINGLE UNIT L

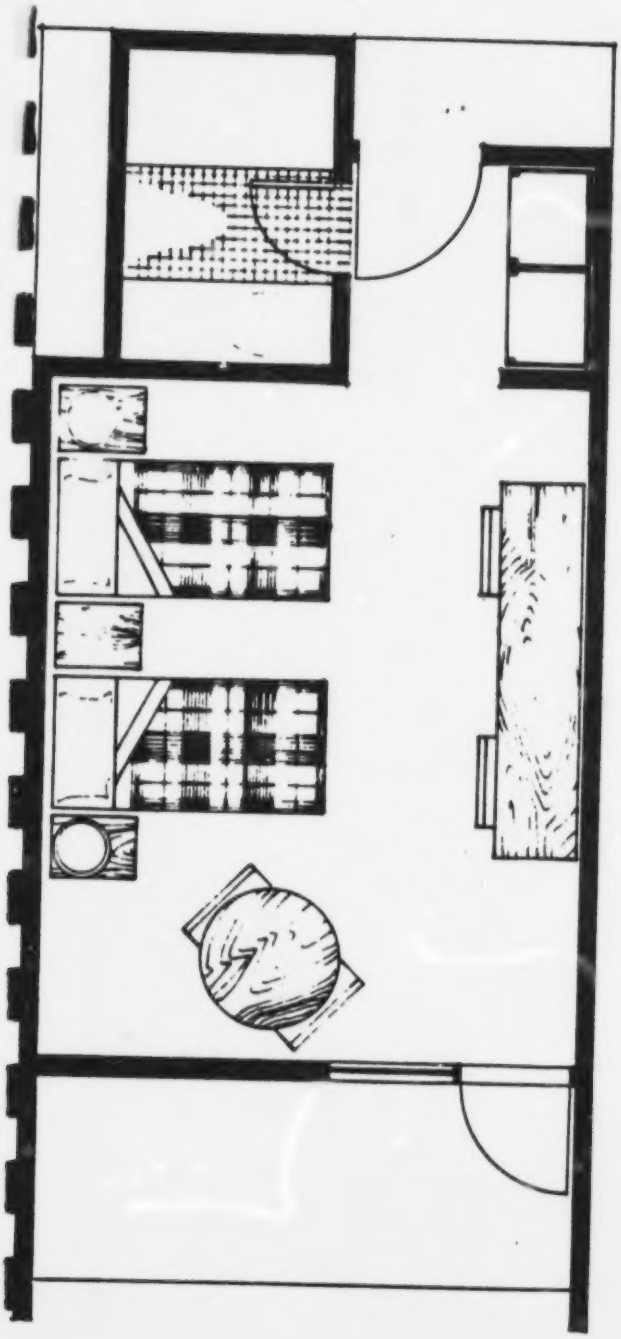
14'-0 x 18'-0 252 SQ FT



SINGLE UNIT R

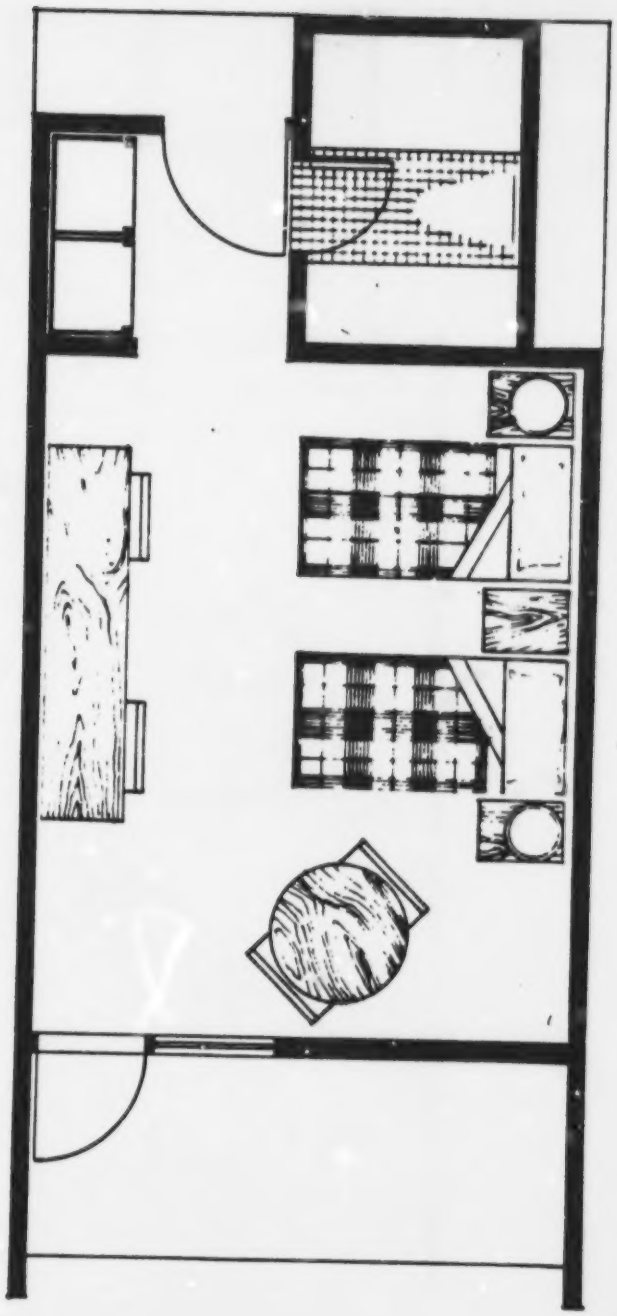
14'-0 x 18'-0 252 SQ FT.

GARRY G. FROST
REGISTERED
ARCHITECT
ALBERTA



SHARED UNIT L

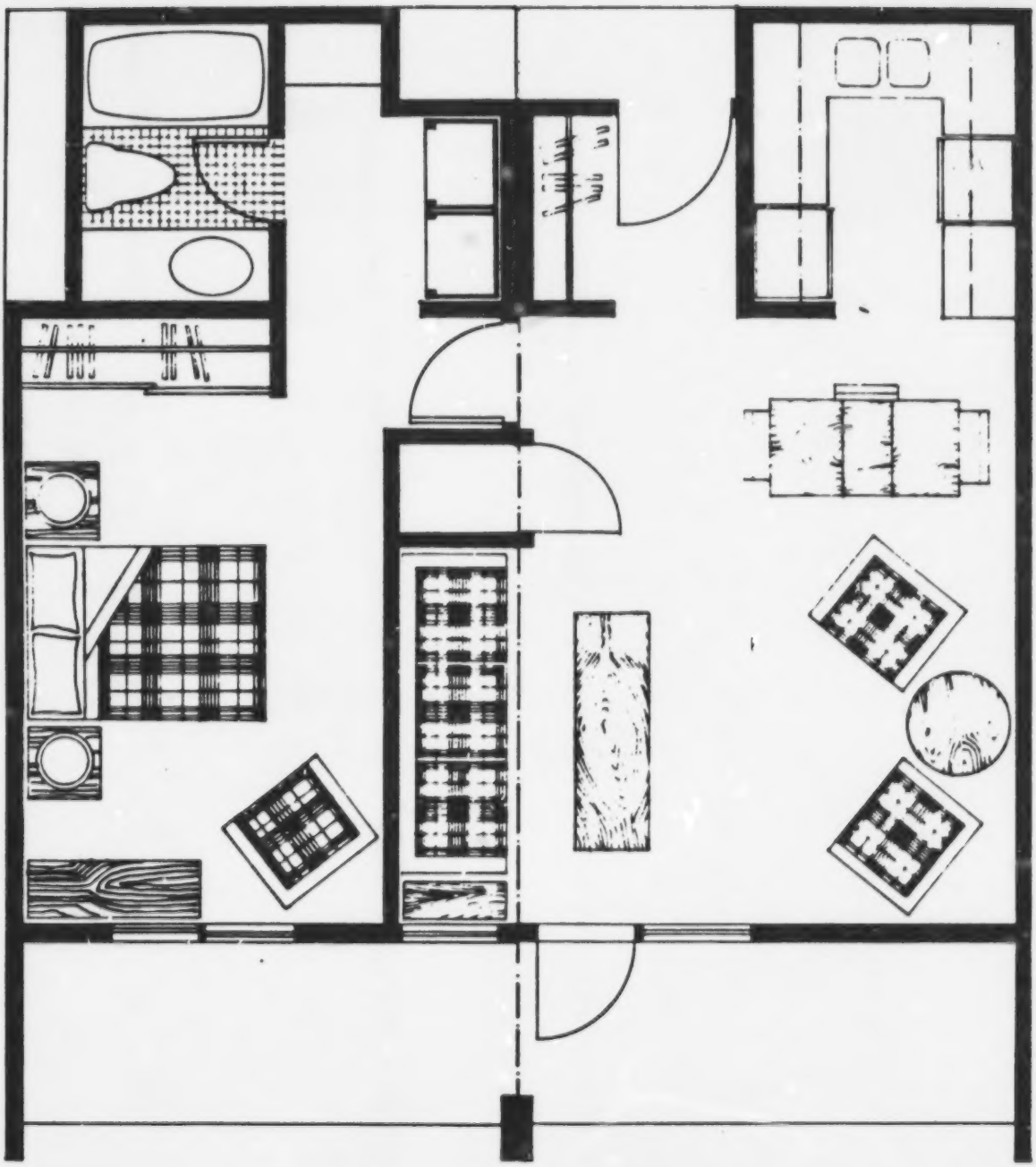
14'-0" x 25'-0" 350 SQ FT



SHARED UNIT R

14'-0" x 25'-0" 350 SQ FT.

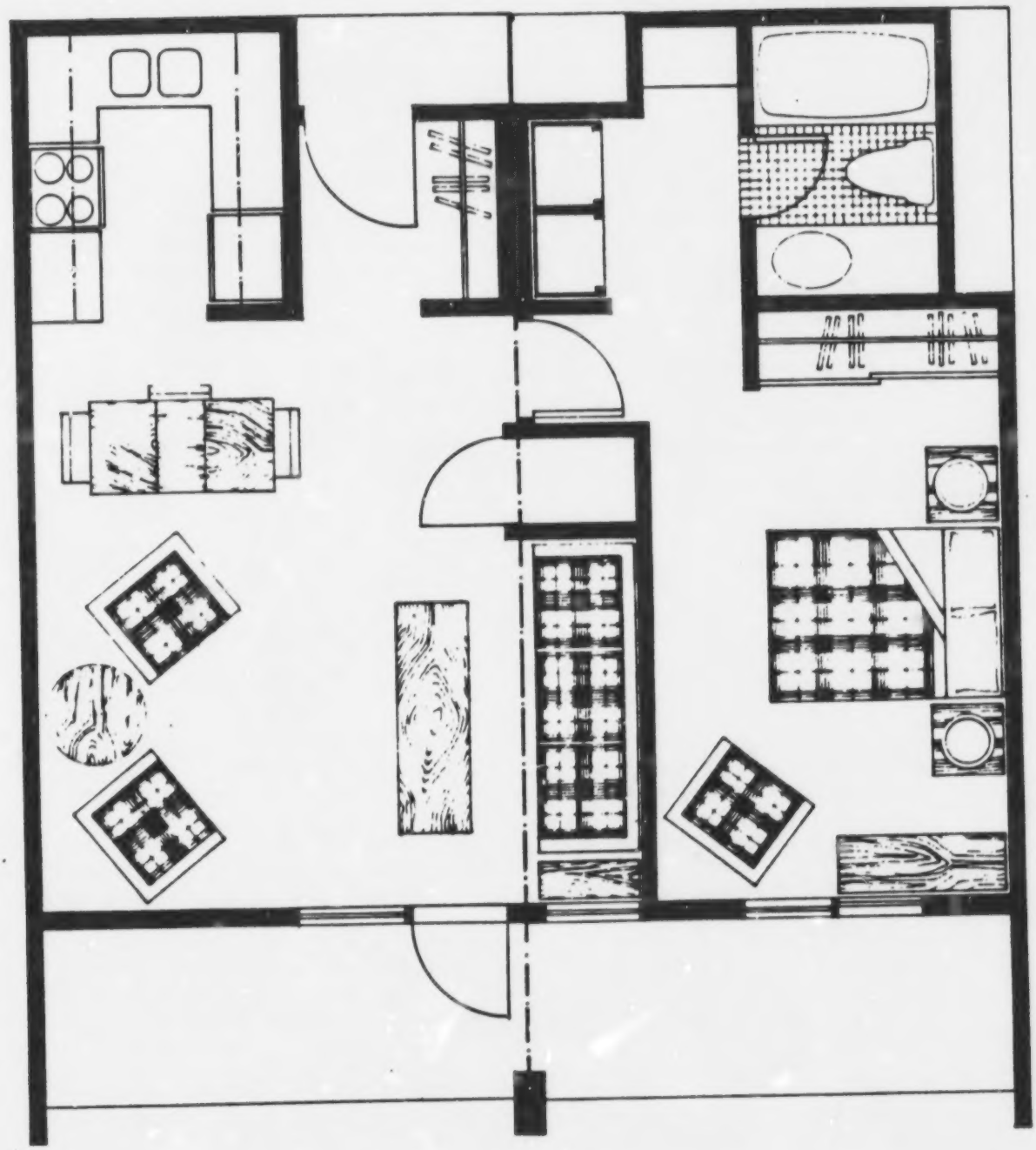
GARRY C. FROST
REGISTERED
ARCHITECT
ALBERTA



APARTMENT UNIT R.

AREA 700 SQ FT.

FROST
REGISTERED
ARCHITECT
ALBERTA



APPARTMENT UNIT L
AREA 700 SQ FT.

CHAPTER 3 - CONTRACT DOCUMENTATION AND MANAGEMENT PROCEDURES

3.1 INTRODUCTION

Several problems with the marketing and the existing delivery system of manufactured housing were reviewed in Chapter 1. These prevent the expansion of manufactured housing into the larger part of the housing market. Briefly reviewed, these are:

1. Vertical segregation within the industry.

2. Restricted market area as a result of product.

3. Contract documents inappropriate for tender by factory builders.

This chapter will present a drawing and management system to encourage the integration of manufactured components and site-building in construction. These systems are important to the resolution of these issues. Without contract documents that clearly define the roles of each participant in the construction, erection and assembly of modular units, there is little chance that manufacturers and site builders can overcome the rivalry that exists between them. Consultants commissioned to design facilities adaptable to modular construction will continue to work within the clearly prescribed confines of conventional construction leaving manufacturers to counter-propose on the basis of their building process.

This disadvantage will do little to promote the industry outside of the traditional markets described in Chapter 1. The use of contract documents that prescribe modular components must above all allow for the important aspects of co-ordination, dimensional control, protection of finished work and responsibility for final finishes presently confounding their competition with conventional construction.

The chapter describes and discusses the contract documents and management procedures necessary for the increased use of manufactured components. Attention will also be directed to reviewing the options available within the system for management responsibility and control.

Drawings included in this chapter have been prepared to schematically illustrate the separation of the manufactured and site built components, into sub-contracts.

The management system is described in terms of applicable contract procedures. In each, participants are assigned a level of responsibility depending on the terms selected. The major participants will be the resource company, the architect, the developer, related consultants, and the contractors: general contractors, manufacturers, and sub-trade contractors. The major roles to be fulfilled will be preparation of contract documents, tendering, co-ordination of construction, supervision and acceptance of completed work and project turn over.

Project development of course begins prior to the appointment of design consultants. In certain situations described in the previous chapters, the resource company may contract for the completion of housing

including the assembly, financing, and purchase of land; the subdivision and approval of lots; and the marketing of units.

These initial tasks are regularly the responsibility of those participating in the speculative housing market. In resource communities, the speculative developer takes a greater risk despite the captive market. Large development companies are wary of taking the full responsibility for the risk especially outside of major urban centres. In partnership with resource companies, minimal guarantees are important.

Guarantees can take the form of assured return on investment or guaranteed minimum occupancies provided by the resource companies. The latter is preferable as it encourages the resource company to accurately assess their need and the developer to approach the market with sufficient profit incentive. A more sensitive and cost efficient product can be offered to resource companies and their employees, in addition to an arm's length relationship.

Land assembly, subdivision and municipal approvals, and financing form the first group of tasks. These will be the responsibility of the developer in a turn-key contract or the owner in a traditional contract. The land may be acquired on long-term lease or purchased by the resource company or developer. Leasing may be preferable in instances where the life-span of the resource is short term (less than 15 years) with the units designed and built to allow for maximum re-use of the components. Municipal design requirements for subdivision and servicing may be less restrictive in closed leases.

This is not significantly different from traditional practice with the possible exception that some resource companies have built an inventory of single family home lots in the communities closest to their operations. The attempt to find land in single family communities supports the trend away from large company developments in new subdivisions.

Approval of the design and construction for mortgage insurance must be gained from government mortgage insurers. Approval in principle from major lending institutions will be required to assure that purchasers will be able to obtain independent financing, releasing the resource company from mortgage responsibilities.

The responsibility for the marketing of the units will be assigned according to the development agreement reached between the resource company and its consultants. Two options exist for the sale of the units. Single-family homes can be built for speculative sales with guaranteed minimum assured by the resource company. Alternately, homes can be ordered for delivery by employees. Prototypes erected at major recruitment centres would allow prospective buyers to choose the type of unit and the lot. Orders would be processed and the unit built and erected on site to coincide with the arrival of the employee in the resource community. This alternative would also allow the opportunity for residents to select the level of finishing of their particular

unit, meeting the stated desire to lower unit costs through "sweat-equity" and add individuality to homes. Traditionally these options have been removed because of the immediate necessity for accommodation. Speculative builders were able to market most forms of accommodation with promises of immediate occupancy.

The second option guards against over-building that can occur in a speculative approach. It can provide an assured product run to maintain competitive product prices superior to the single unit price of current individually-built units. Moreover, it provides additional protection to the resource company who, in advancing guarantees to a developer or contractor, must make certain assumptions based on future events.

3.2 CONTRACT DOCUMENTATION

3.2.1 DESCRIPTION

The contract documentation uses a two volume format which describes separately the work to be done in the factory by the manufacturer (Volume I) and the work to be completed on site by subtrades (Volume II). A composite master volume for use in assembly and erection provides both volumes for final inspection and assignment of warranty work.

Each volume is organized into chapters focusing on sequential aspects of the work:

Chapter 1 - Includes the context plan, a listing of the applicable codes, general design criteria for all sections of the work and the table of contents.

Chapter 2 - Contains the site plan and all site work including major connections to sewer, water and power lines.

Chapter 3 - Provides information for the construction of substructure and foundations.

Chapter 4 - Contains composite drawings and provides general information for the client and manager.

Chapter 5 - Provides all information for the construction and location of the modules.

Chapter 6 - Provides detailed construction information for factory production.

Chapter 7 - Describes work on the interior and exterior partitions at the site.

Chapter 8 - Provides details relevant to on-site construction.

Chapter 9 - Contains information for heating, ventilating and air conditioning contracts.

Chapter 10 - Provides information for the site connection of plumbing.

Chapter 11 - Documents all on site electrical work.

The primary advantage of using the two volume multi-chapter system of organization is the opportunity to break down the information into its component parts. This removes complexity from the individual portions of the work for manufacturers and subtrades. Colours further increase clarity; dimensions are printed in one colour, notes in another. Contextural information not directly related to the work of the chapter can be screened to a half-tone.

Bidding options can be clarified by screening techniques or colour identification. The drawings in Appendix I illustrate two options of site construction. Sheet 2.1 details the application of siding, roof construction, construction of corridors and the enclosure of plumbing chases after hook-up. Sheet 2.2 prescribes the painting of rooms and application of ceiling finishes as additional site work. These options would be further clarified in more detailed tender documents.

Overlays on base drawings allow sections of information to be removed when necessary. This decreases the work load involved in contract changes or preparation of as-built drawings. Each chapter is dependent on the information of the chapter preceeding it. This sequential preparation is ideally suited to fast-track construction contracts; Chapter 2, Sitework, can be contracted while sequential chapters of the contract documents are prepared.

An example in Figures 3:1 to 3:3 illustrates the mechanisms of the two volumes of work as well as the composite.

3.3 CONTRACT PHASES

CONTRACT DOCUMENTATION

Contract Documents will be included as part of a comprehensive service package or on separate contract between the resource company and the design consultants.

The two-volume document system described above is combined to provide composite drawings for the co-ordination of the construction. The particular type of contract procedure will determine the amount of information and the level of detail contained in each package.

In a comprehensive package, the division of the work for factory and on-site finishing can be determined by the project team according to economic and aesthetic criteria. Cost monitoring throughout the contract documentation stage is crucial to assure the best use of resources and to prevent budget overruns.

Project management or traditional tender contracts will rely on the experience of the design consultants and bidding contractors in the decision of labour division between the factory and the field. This is

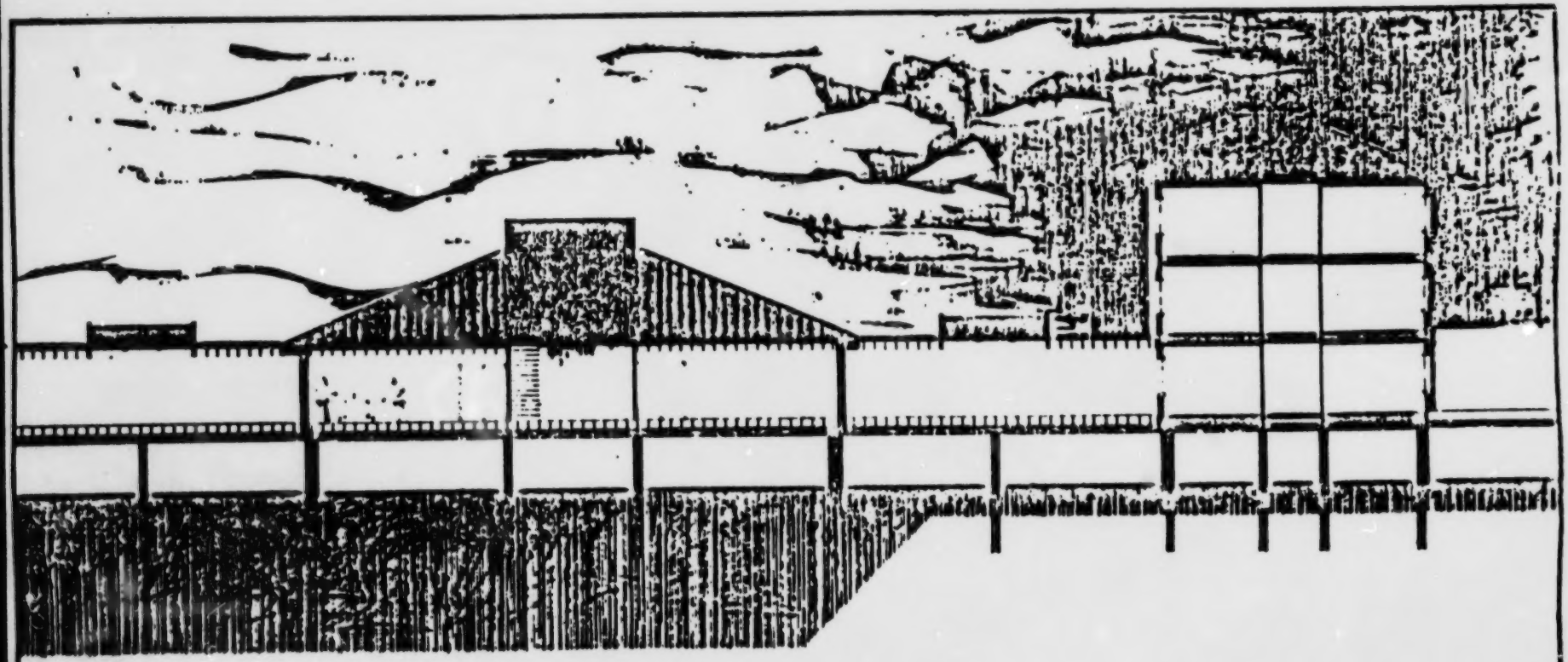
FIGURES 3.1 - 3.3

CONTRACT DOCUMENTS - EXAMPLE

Volume 1, Sheet 6 illustrates the modular construction information with the site construction screened. This screening serves to highlight the particular aspect of the work described while maintaining the context of the final product. A more detailed set of contract drawings would show each module in section as part of volume one.

Volume 2, Sheet 12 illustrates site construction with modular construction screened out. This drawing would provide the site contractor with the information necessary to establish this responsibility.

Volume C, Sheet 7, the composite of these two drawings would provide the section of the finished building for information to the client.



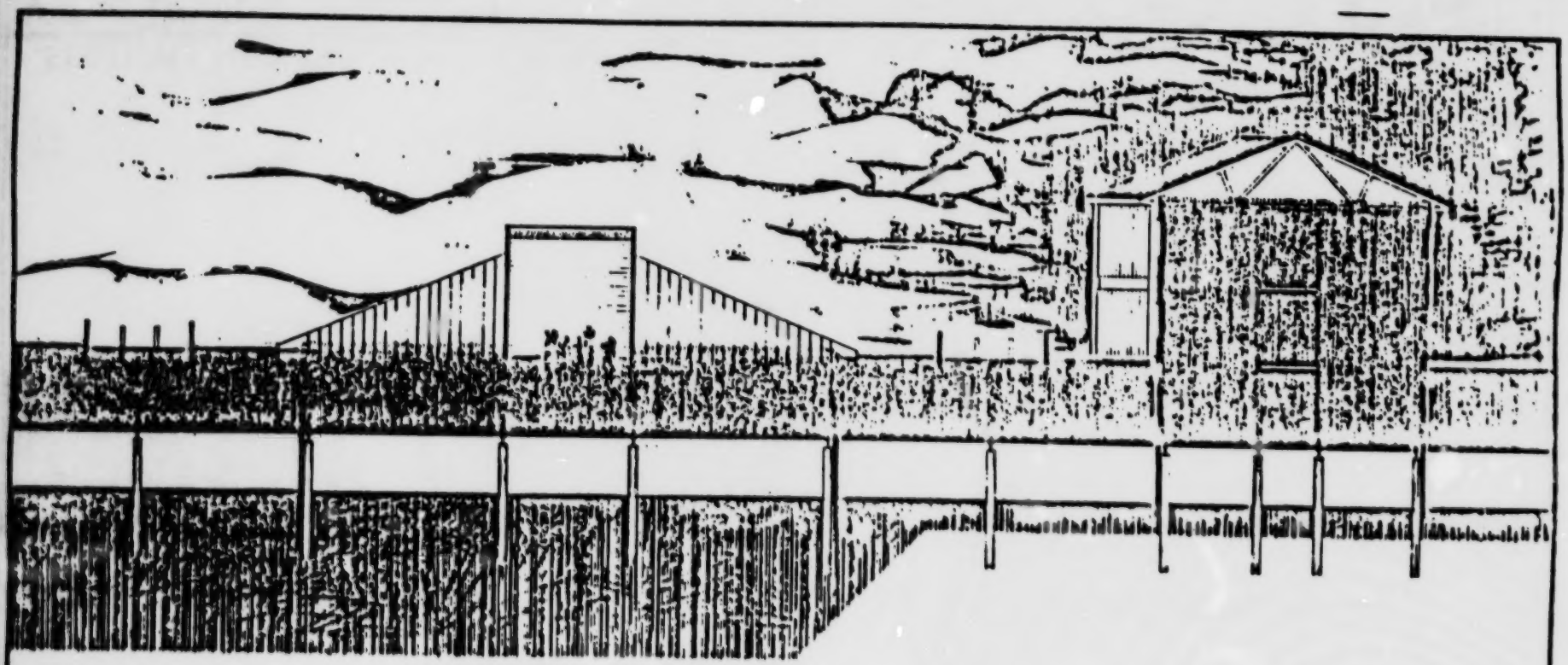
43.

SECTION MODULAR CONSTRUCTION

VOLUME 1 / 6 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)

Gary C frosi
Architect ltd

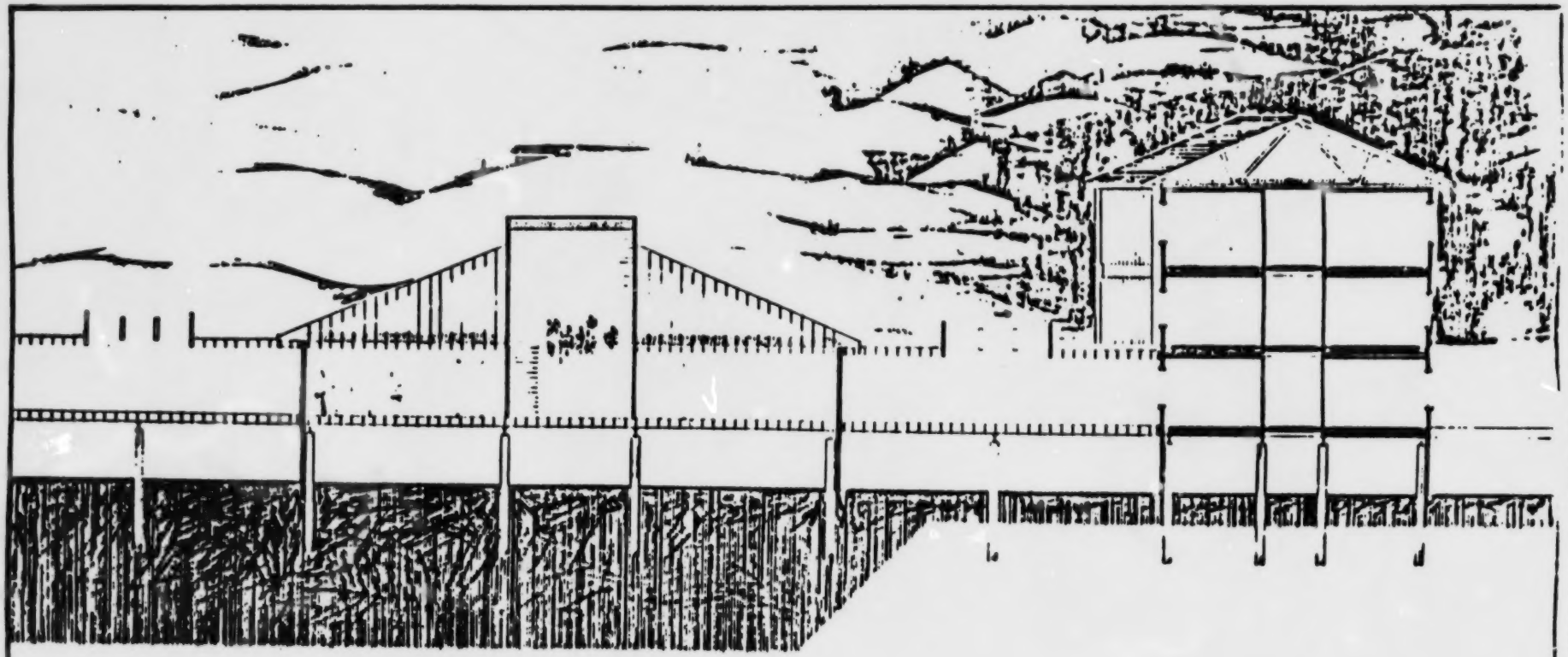


SECTION SITE CONSTRUCTION

VOLUME 2 SHEET 12

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)



45

COMPOSITE SECTION

VOLUME C / 1 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)

gary c frost architect ltd

not a great disadvantage but may reduce the economies of a comprehensive approach.

PROJECT TENDER

Previous experience in tendering of site construction using this system supports the claim of clarity. Fewer calls for clarification are reflected in more secure and accurate bidding by all trades.

Unit price contracts are also possible with the dual-volume documentation. To assure proper co-ordination within the complexity of large scale residential construction, responsibility for warranty control should be handled by those directly accountable for the construction quality.

On tender closing, the work will be awarded and the inspection control carefully monitored by the parties awarded the tender and the developer or project manager.

CONSTRUCTION

The phasing of construction in the factory and the site will be monitored by the project manager, developer or general contractor. The volume and chapter format of contract documentation is clearly adaptable to simultaneous work in the field and the factory.

In Appendix I, factory production has been shaded in the drawings intended for the site contractor. Detailed enlarged plans and elevations would form the major part of the drawing volume sent to the manufacturer. Specifications for that section of work would accompany the graphic instructions.

Inspection of the factory-built modules would occur in three stages; at the plant, (monitoring of production), on arrival at the site, and after installation. The level of finish of the units is of primary concern in this three point inspection phase. In some cases, the interior partitions are fully complete at the plant gate. During transportation, installation or completion of site work there may be damage that is not attributable to the manufacturer. Partial completion of the units at the factory, that is to the taping of interior drywall, is recommended. Final completion at the site can more quickly compensate for damage without the warranty problems that arise from repair or touch-up work completed by other trades.

A comprehensive management and construction team makes this type of situation easier to define and control, if the production of contract documents and the construction phase are prepared and co-ordinated to maximize the economy of on-site labour.

Site preparation and setting of building foundations can be scheduled during the factory set-up and initial stages of production. The importance of preventing delay once the units have arrived on site is essential. In the construction system proposed, factory units are

temporarily protected, and final exterior finishes are added at the site. This ensures an integrated facade. Careful scheduling to minimize exposure of the modules prior to installation is a primary responsibility of the appointed co-ordinator.

The size of the project will determine the most economical means of transportation. It is expected that minimum economies of scale required for a viable production run in the factory will be congruent with the number of units required for an economical lease of tractor trailer units under contract to the manufacturer or the general contractor. The supervision of transportation must be allotted to a party with ultimate responsibility in construction and warranty. This is critical to assessing and repairing any in-transit damage.

The co-ordination of on-site work, the project location and the means chosen for contract management each affect the choice of bidding options. As mentioned above, the use of sub-trades required for site work may be co-ordinated with the finishing work required after the installation of modules, without adding significantly to the contract price. The available labour supply and the potential for damage during construction must also be considered. For example, a project location accessible only by water will be subject to potential damage in transfer of modules from trucks or rail beds to barges. Finally, the experience and expertise of the project co-ordinator will play a part in the degree of finishing at the site. The importance of economical and full use of site labour is essential in remote locations where administrative costs must be minimized.

INSPECTION, TURN-OVER AND WARRANTY

The completion of the project and the turn-over to the owner is marked by the final inspection. As much of the work has been constantly monitored throughout construction this phase will be simplified. The composite drawings can be used with reference to separate volumes in cases of dispute. Warranty inspection follows a similar procedure.

3.4 CO-ORDINATION OF FACTORY BUILDING AND CONSTRUCTION

Essential to the use of this building system is the drawing methodology illustrated and discussed in Section 3.2

The drawing method provides clear separation of responsibility for the manufacturer and site contractor. The volumes produced for each construction phase provide without doubt the clarity required to mediate disputes.

The ideal management system chosen to coincide with the drawing system has some essential components. Overall co-ordination and familiarity with scheduling of on-site construction is important to maintaining the economy possible in the combination of factory building and on-site completion. Few contractors have had experience with manufactured components and conversely few manufacturers are familiar with the scheduling and cost economies of site building. For this reason, the turn-key or design build contract is promoted as the most suitable

contract procedure. Its structure is described in the following section.

3.5 CONTRACT MANAGEMENT

The potential time-advantage of using modular components in resource community construction is best complimented by a contract that incorporates sequential tendering, that is a project management or design-build contract. Cost and time savings in these systems increase the advantages offered by off-site construction of modules. These two contract options also offer greater advantage in site co-ordination and monitoring. A major role is allotted to the inspection procedure in the proposed system and the addition of an independent (or semi-independent) co-ordinator will assist in the resolution of disputes.

The early selection of the contract parties who will provide co-ordination from the outset of the project to the turnover, is also an advantage to projects using this method.

The tasks and responsibilities assigned in the management system will not differ according to the contract type selected. The actors and their responsibilities will.

Three contract types may be used to demonstrate the management system. They are:

1) Design-build proposals

2) Project or Construction Management

3) Traditional Tender - Stipulated Sum Contract

The essential aspects and options offered by these contracts are illustrated in the diagrams following.

3.5.1 DESIGN-BUILD (TURN-KEY) MANAGEMENT

The design-build or turn-key contract presents what was initially indicated as the most attractive alternative to the resource company. Primarily it offers an arm's-length relationship between the company and its residential accommodation; it offers the expertise of design teams and developers familiar with residential construction; and it can be tailored to include services necessary to the on-going operations and maintenance of the completed project.

Figure 3.4 shows the contractural responsibility of the developer to the owner. This role will be filled by a number of experts forming a team with expertise in; land assembly, marketing, design, management and construction (factory and site built). The prior co-ordination of these team members to provide the required product without the need for

separate contracts for each phase, is a primary advantage to the resource companies.

The design-build or turn-key system best complements the time and cost economies of factory built accommodation. Simultaneous completion of tasks illustrated in the Figure 3.8 confirms this potential.

The special requirements of resource community accommodation may warrant additional consultants to the team. Union committees play a large role in employee relations in the resource industries. The location of many communities often determines the existence of additional regulatory bodies having jurisdiction. In Coal Valley for example the Energy Resources Conservation Board may control property leases and use.

The superior management co-ordination of a developer team in all aspects of the work from pre-design to operational management assures the resource company that they will not be called from their area of expertise, that is resource extraction, to handle problems. Their sole participation will be in providing the accommodation requirements and the minimal guarantees for occupancy described earlier.

The use of this contract model will not be ideal for all resource companies, particularly in on-site accommodation. The construction of accommodation within the immediate vicinity of an extraction or processing area requires more direct control by the resource company for planning co-ordination and safety during construction and operation of the facility. This case was demonstrated during the course of the research by two resource companies.

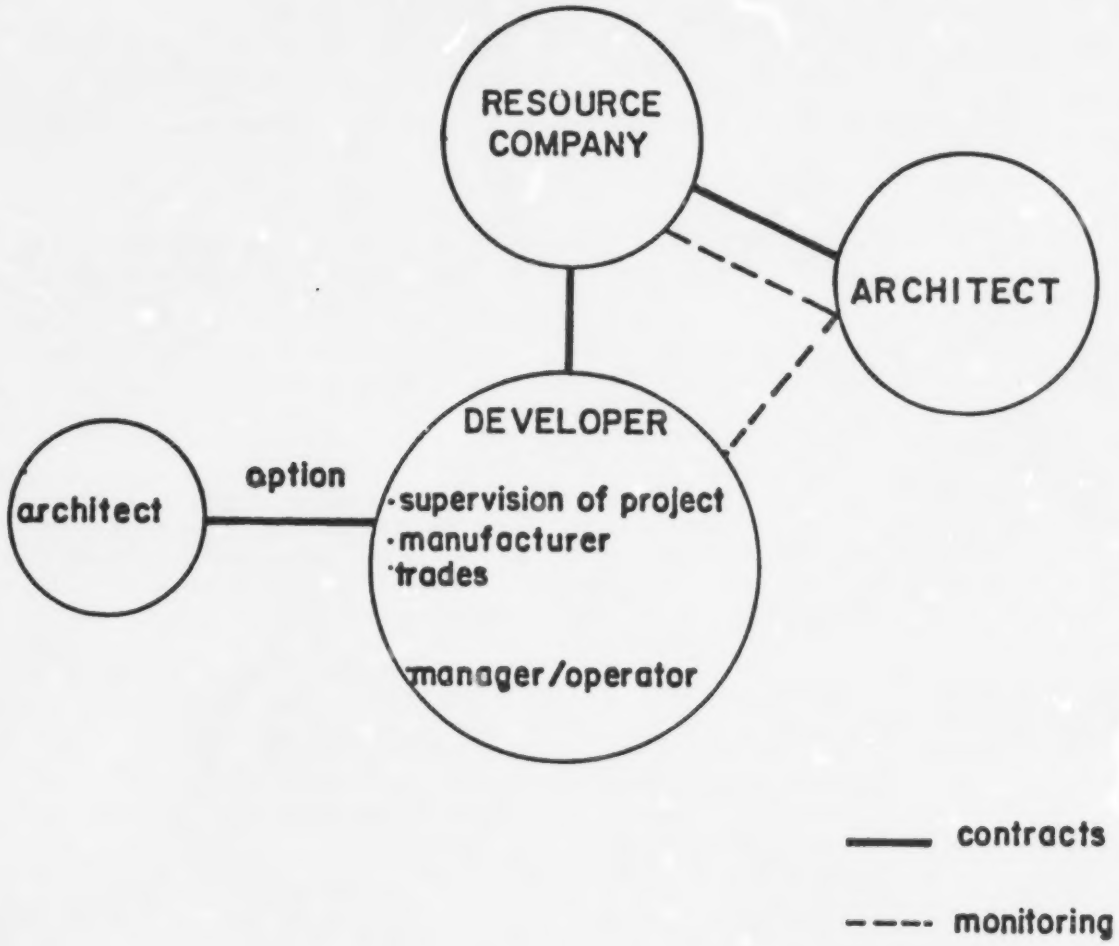


FIGURE 3:4 DESIGN - BUILD CONTRACT

RESOURCE COMPANY
Contracts directly with developer.
Provides requirements and specifications (through Architect).
Provides minimum guarantees for occupancy.

ARCHITECT
Option 1. Contract with Developer
Option 2. Contract with Resource Company
Provides designs and specifications.
May provide specific contract drawings. Option 2.
Monitors construction as owner's agent. Option 2.

DEVELOPER
Provides comprehensive service package including:
land subdivision, municipal and union approvals, marketing of accommodation to employees, supervision and completion of construction and operating services.

20.

3.5.2 PROJECT OR CONSTRUCTION MANAGEMENT

In cases where the resource company is prepared to play a direct role in the construction of accommodation a project or construction management contract can be employed. As a result of discussion with key informants this management model is more appropriate to insure that planning, design and safety criteria are clearly prescribed in constructing permanent accommodation at a plant or extraction site.

The project management contract diagram in Figure 3.5 illustrates the contract responsibilities and lines of communication in this model. The supervisory position can be an employee of the company or an independent consultant hired by the resource company. A supervisor familiar with the detail of residential construction is preferable to one experienced in large scale engineering contracts. In the latter case, the transfer of knowledge has appeared to be less than ideal.

This approach eases the potential conflict between manufacturers and on-site contractors. The vertical segregation and restricted market areas of these two groups has in the past allowed the independent supervision of projects resulting in problems in control and warranty responsibility. The responsibility of both parties can be attained through the employment of a project or construction manager, independent of the participating contractor.

Sequential tendering can be accommodated in this type of contract as shown in Figure 3.7. Cost-monitoring and inspection throughout construction can be assured.

The project management contract alternative provides the owner with a greater degree of control after the contract is signed. This control increases the overall involvement in the decision making and approval process accompanying changes in scope.

3.5.3 TRADITIONAL TENDER - STIPULATED SUM CONTRACT

In this approach, the architect works directly with the resource company in developing the design concepts and drawings. The degree of participation is a primary advantage of the system, to some companies.

The primary tasks illustrated in Figure 3.6 occur on a sequential basis from the selection of the design consultants to the project turnover. This complicates fast-tracking of the work.

The resource company is primarily responsible for the inspection and acceptance of the work on the advice of the design team. Payment is made directly to the general contractor by the owner.

There is an option for the owner to maintain a separate contract with the manufacturer on a unit price basis. This situation is uncommon in construction because of the complexities that arise in the co-ordination of the work.

A second option exists in engaging a manufacturer in lieu of a general contractor. This assumes that the manufacturer has the proven capability to supervise the operation beyond production in the plant.

The traditional tender increases the competition between project bidders in certain markets. With the contract documents proposed in this research, bidding can occur with more certainty. Clear reproduction can substantially reduce the usual guess-work involved in tender estimating.

This contract procedure is appropriate in small projects where the economy of long production runs or the maximum use of factory time is less critical to the overall project cost.

In using a traditional tender, the general contractor or the manufacturer maintain the primary responsibility for completion and warranty of the work within the bid price. Ultimate responsibility placed on either one party or the other will encourage the smooth flow of contract obligations to the owner.

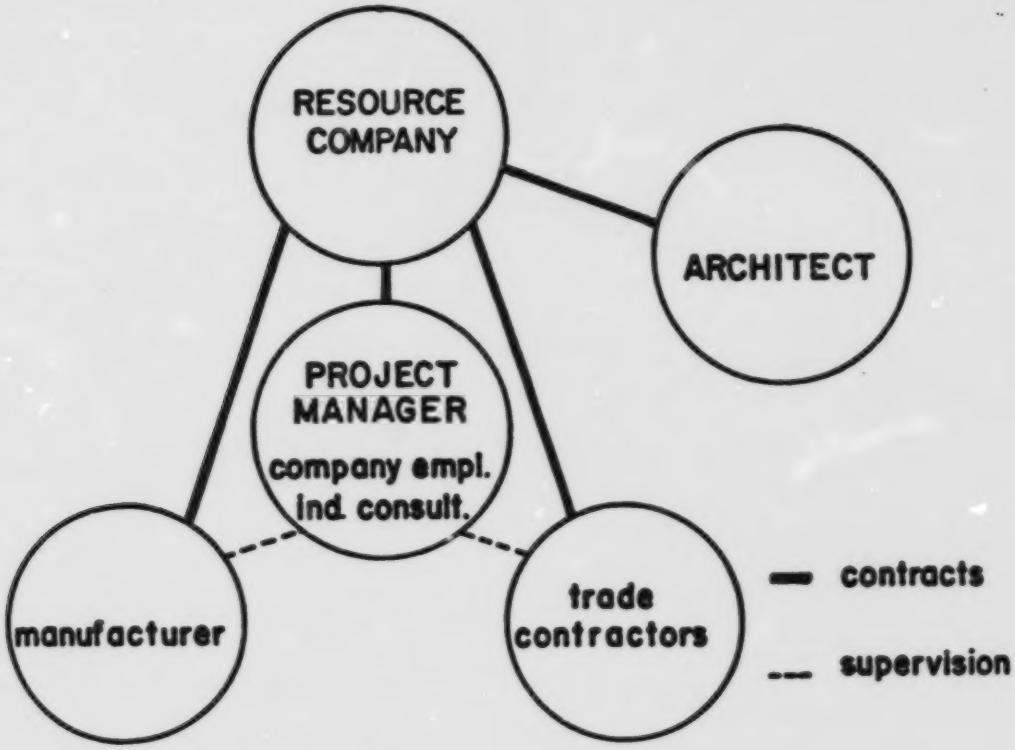


FIGURE 3.5

PROJECT MANAGEMENT

RESOURCE COMPANY
Contracts directly with all consultants and subtrades.
Takes over project on completion of construction.

PROJECT MANAGER
Employee of the Resource Company or Independent Consultant.
Monitors costs throughout the project.
May provide guaranteed maximum price.
Administers all design and construction work.
Co-ordinates on-site construction.

ARCHITECT (AND DESIGN CONSULTANTS)
Prepare design drawings in consultation with the client.
Prepare sequential tender documents in consultation with project manager.
Inspect quality of work.

MANUFACTURER
Completes all factory work including delivery to site.

TRADE CONTRACTORS
Finish units on site.

Option
A construction manager may be appointed after the design stage is complete.

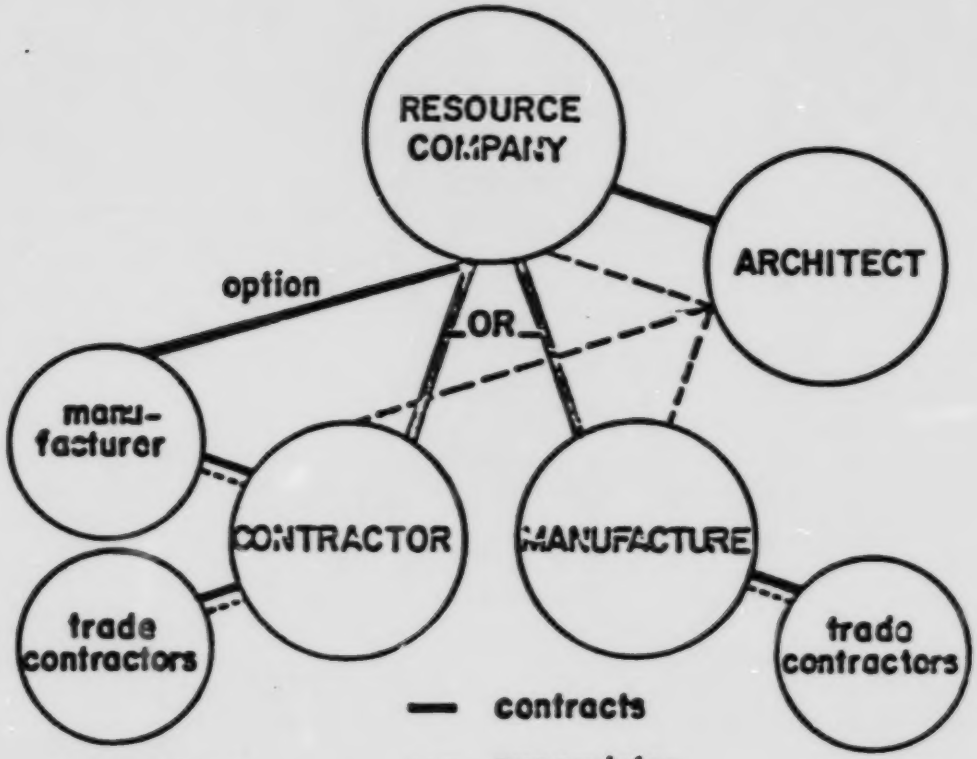


FIGURE 3.6

TRADITIONAL TENDER

RESOURCE COMPANY
Contracts directly with architect.
Reviews tenders.
Selects general contractor (manufacturer).
or
Selects general contractor and manufacturer.
Monitors construction through the architect.

ARCHITECT (AND DESIGN CONSULTANTS)
Prepare design drawing for client approval.
Prepare tender documents.
Advise resource company.
Monitor, administer and inspect completed work.

GENERAL CONTRACTOR
Obtains all permits and insurance.
Supervises and co-ordinates all site work.
Contracts directly with subtrades (and manufacturer).

MANUFACTURER
Under one option the manufacturer will manufacture, transport and supervise the installation and completion of the building.

TRADE CONTRACTORS
Prepare site and finish units under contract to the General Contractor or Manufacturer.

24.

3.6 CONCLUSIONS

The clarity of the contract documents, separating the work of the manufacturer from the site contractor is essential to the integration of factory-built modular units into the construction of housing in remote areas.

The scope of work drawings appendixed to this report demonstrate the clarity that can be achieved using overlays. The addition of coloured notes and dimensions will increase the visual definition of contract instructions essential to the co-ordination of work carried out at separate locations.

The opportunity to expand from the dimensional constraints imposed by transportation is a major advantage in expanding the restricted market of housing manufacturers. The integration of the separate actors within the industry and the co-ordination with site-contractors will develop with the confidence available in the clear definition of tasks and construction responsibilities available in the coloured overlay system of contract documentation.

As designers and consultants adapt to this means of documentation, the potential for widespread use of modular components in a variety of building types in remote areas is possible. The cost and quality advantage to resource companies and others developing in remote locations will provide the incentive for further design innovation and technical improvements.

A design-build process offers full service to the client with minimal participation in the administration and supervision. This process was apparently more desirable for family accommodation - removing the stigma of company housing. There was a need foreseen for some control especially in selecting lots and approving designs.

Greater participation is allowed the resource company in the project management process. This advantage is necessary in the construction of accommodation at the plant or extraction site. The site area may be subject to certain requirements as a result of its proximity to the main operations. Safety regulations in heavy mining can present the necessity for a project manager in direct communication with the resource company throughout the construction process.

A traditional tender increases the competitive nature of construction bids especially in a recession. This and the company's ability to give full input on all phases of design and construction are the greatest advantage of this process. Contract supervision and administration is controlled through the resource company on the advice of the design consultants.

Discussions with key informants indicate that each of these three approaches has merits. The selection of an appropriate contract procedure will depend therefore on the size of the project, the type of accommodation required, the life-expectancy of the accommodation and the degree of participation desired by the resource company in the design and construction of the units.

CHAPTER 4 - COST ESTIMATES

4.1 INTRODUCTION

Applying the design and management systems presented in the previous chapters, the estimated costs of the unit types were solicited from manufacturers and site contractors. This chapter will present, and discuss these costs and compare them to existing alternatives available to resource community residents.

The drawings submitted for estimate are scope of work drawings with detail equivalent to those prepared for estimates in a typical design-build project. The accuracy of the cost estimates is predicted to be within 10%, acceptable within the scope of this research.

4.2 SINGLE FAMILY HOUSING

A project management format was used to procure estimates for the single family units. The contract documents were divided into factory work and site work. Rocky Mountain House, a community 300 kilometers south-west of Edmonton was chosen as the hypothetical location. The project was six units (twelve modules), the minimum number necessary to take advantage of the economies of scale in the plant.

Refer to Table 4.1 for unit cost estimates.

The quoted prices are consistent with other research, supporting the hypothesis that factory building can reduce the cost of housing. The difference in this study is the co-ordination offered in combining site finishing with the manufacturing process to produce a house superior to the traditional manufactured home, while maintaining the cost competitiveness and ease of construction presently available. The clarity of the contract documentation system presented in this research is the key to this union of manufactured and site-built construction processes.

A great deal of discussion with the key informants indicated areas where greater price savings were available. The highlights of these discussions will follow.

4.3 CAMP HOUSING

An entirely different situation arose in the cost estimates for the industrial camp prototype. In this case, the project was designed to meet the specific requirements of a resource company in Fort McMurray, Alberta. To illustrate a traditional tender process, a manufacturer and a quantity surveyor/contract manager participated in the cost analysis. The manufacturer provided prices for the total project assuming that foundations and site finishing would be sub-contracted. The contractor estimated the cost of site construction for comparison.

The project represented a step forward from the traditional single story, 42-man module camp. It was based on a unique design prepared with the market information assembled in the initial phases of this

TABLE 4.1: COST COMPARISON - SINGLE FAMILY UNIT A
145 square metres

	Site Built	Modules/Site Finished
Excavation	1,700.00	1,700.00
Foundation	6,725.00	6,725.00
Siding	2,795.00	2,795.00
Roofing	2,390.00	2,390.00
Rough Carpentry	10,900.00	2,655.00
Finish Carpentry	1,490.00	450.00
Glazing	4,800.00	300.00
Insulation/Wallboard	5,040.00	400.00
Doors	1,950.00	
Hardware	250.00	
Ceramic Tile	250.00	
Floor Covering	2,500.00	
Painting	1,200.00	
Fitting (Specialties)	4,190.00	
Plumbing/Heating	4,500.00	
Electrical	2,800.00	
Decks	1,920.00	1,440.00
Site Overhead	5,400.00	2,100.00
Modular Unit		27,500.00
Transportation		2,225.00
Installation/Hook-up		5,000.00
Sub Total	60,800.00	55,680.00
Fee	3,040.00	1,100.00
TOTAL	$63,840.00	$56,780.00
Cost per square metre	$ 440.00	$ 391.60
Cost per square foot	$ 40.90	$ 36.40

Saving - 11%

The prices in this table are compiled from cost information in the summer of 1983.

Site built costs represent a medium quality unit with wall insulation of R-30 and ceiling insulation of R-40. Light wells to the basement, unit decks and patio doors are included as standard features and add some premium to the house cost. These features are important aspects of the expressed wishes of the resource community market.

The module/site-finished units are those constructed within the concept of this research. The end product is identical to the site-built unit. Transportation costs are presented for Rocky Mountain House and installation and hook-up are extrapolated from a daily cost for an erection crew.

TABLE 4.1: COST COMPARISON - SINGLE FAMILY UNIT B
145.5 square metres

	Site Built	Modules/Site Finished
Excavation	1,648.00	1,648.00
Foundation	7,720.00	7,720.00
Siding	2,860.00	2,860.00
Roofing	2,350.00	2,350.00
Rough Carpentry	10,518.00	2,230.00
Finish Carpentry	1,540.00	450.00
Glazing	4,640.00	300.00
Insulation/Wallboard	5,344.00	580.00
Doors	1,950.00	
Hardware	250.00	
Ceramic Tile	250.00	
Floor Covering	2,650.00	
Painting	1,200.00	
Fitting (Specialties)	4,200.00	
Plumbing/Heating	4,500.00	
Electrical	2,800.00	
Decks	1,920.00	1,440.00
Site Overhead	5,400.00	2,100.00
Modular Unit		27,600.00
Transportation		2,225.00
Installation/Hook-up		5,000.00
Sub Total	61,740.00	56,503.00
Fee	3,100.00	1,100.00
TOTAL	$64,840.00	$57,603.00
Cost per square metre	$ 446.00	$ 395.90
Cost per square foot	$ 41.45	$ 36.80

Saving - 11%

The prices in this table are compiled from cost information in the summer of 1983.

Site built costs represent a medium quality unit with wall insulation of R-30 and ceiling insulation of R-40. Light wells to the basement, unit decks and patio doors are included as standard features and add some premium to the house cost. These features are important aspects of the expressed wishes of the resource community market.

The module/site finished units are those constructed within the concept of this research. The end product is identical to the site-built unit. Transportation costs are presented for Rocky Mountain House and installation and hook-up are extrapolated from a daily cost for an erection crew.

TABLE 4.1: COST COMPARISON - SINGLE FAMILY UNIT C
126.6 square metres

	Site Built	Modules/Site Finished
Excavation	1,575.00	1,575.00
Foundation	6,255.00	6,255.00
Siding	2,654.00	2,655.00
Roofing	2,140.00	2,140.00
Rough Carpentry	9,867.00	2,870.00
Finish Carpentry	1,520.00	450.00
Glazing	5,274.00	600.00
Insulation/Wallboard	4,780.00	400.00
Doors	1,950.00	
Hardware	250.00	
Ceramic Tile	250.00	
Floor Covering	2,020.00	
Painting	1,200.00	
Fitting (Specialties)	4,267.00	
Plumbing/Heating	4,500.00	
Electrical	2,800.00	
Decks	1,840.00	1,400.00
Site Overhead	5,200.00	2,100.00
Modular Unit		24,100.00
Transportation		2,225.00
Installation/Hook-up		5,000.00
Sub Total	58,342.00	51,770.00
Fee	3,000.00	1,025.00
TOTAL	$61,342.00	$52,795.00
Cost per square metre	$ 484.50	$ 417.00
Cost per square foot	$ 45.00	$ 38.75

Saving - 14%

The prices in this table are compiled from cost information in the summer of 1983.

Site built costs represent a medium quality unit with wall insulation of R-30 and ceiling insulation of R-40. Light wells to the basement, unit decks and patio doors are included as standard features and add some premium to the house cost. These features are important aspects of the expressed wishes of the resource community market.

The module/site finished units are those constructed within the concept of this research. The end product is identical to the site-built unit. Transportation costs are presented for Rocky Mountain House and installation and hook-up are extrapolated from a daily cost for an erection crew.

project, integrated with the specific requirements of a resource company client.

The manufacturer, acting as key informant, had recently participated in a contract combining modular construction and site finishing. In the opinion of the authors, this experience, coupled with the co-ordinating problems of a traditional bid process, led to an extremely cautious estimate, especially for field construction.

The estimated price was $51.21 per square foot including $30.30 for factory fabrication and $1.50 for transportation. The cost of constructing the accommodation at the site was estimated at $35.00 per square foot. The estimated costs of the site contractor were not provided in the detail required to compare them to the manufacturer's cost, so the discrepancy can only be explained in general terms.

The use of non-union labour by the general contractor will reduce the cost of site building in a region with an established labour supply. Fort McMurray has such a labour market, especially in the current economy. The greater experience of the site contractor with site work; especially foundations, roofing and exterior finishes, undoubtedly assisted in arriving at more specific prices. Discussions with the manufacturers indicated that some caution was used in the estimate of site work because of the nature of the bid process established by the resource company.

The cost difference between the industrial manufacturers and the single-family home manufacturers is also significant.

There are some differences in the approach of industrial trailer manufacturers and single family home manufacturers. The former in servicing the resource industry market has traditionally employed union labour. Because a lower level of overall skill is required, the cost is less than the cost of skilled tradesmen in field construction. However union labour is still at least twice the cost of non-union labour used in smaller operations. Single family home manufacturers are subject to less rigorous code inspection than industrial camp manufacturers. The codes of the Canadian Standard Association for manufactured homes are enforced on the basis of periodic inspection of factory production. Industrial camps on the other hand are subject to inspection for compliance with the National Building Code prior to occupancy. Camp accommodation must also be constructed to withstand transportation to remote areas, exposing them to greater stress than single family homes moved to sites more accessible from major highways. Finally, the scale of camp projects has at all times required more engineering work in structural, mechanical and electrical systems. Thus a small difference in cost might be expected, if the volume of production does not fully balance those additional engineering costs.

Both the industrial manufacturer, and the mobile home manufacturer have each spent considerable time and effort developing a product which suits the unique need of their specific market. This time-tested product development has proven marketable over time and in some cases will remain so. Both types of manufacturers refer to their units as

product. Even the mobile home dealer, when ordering more trailers, orders more product. But this prevailing view of the product has led to less emphasis on adapting process skills to new market opportunities that might be available to the two segments of the industry.

Innovative design is often looked upon as a deviation from the manufacturers standard product line. Changes from the standard, and the implication of retraining, retooling and interruption of existing production schedules are usually viewed with skepticism by the manufacturer. This suspicion is often reflected in higher quoted prices for innovative projects or a reluctance to quote altogether.

The real product of the manufacturer, is the application of their manufacturing process to innovative design solutions. Should some of the organizational and contractural uncertainties of the process be alleviated by this study, the prospect of expanding markets is clear. But should the manufacturers continue to hold to their established product, and apply this to innovative forms, the result will be disfunctional and ultimately expensive.

4.4 COST DETERMINANTS

The discussion of the manufacturing process and these cost estimates will be directed to the following areas:

1. the length of production runs.
2. the costs of assembly components
3. transportation modes and costs
4. unit erections costs and
5. site servicing and utility connections.

4.4.1 LENGTH OF PRODUCTION RUNS

A housing manufacturer has fixed overhead costs many of which are independent of production volume. Adjustments to the production line are also necessary for each design alteration. Thus even small increments in the number of units produced, will decrease the cost overhead per unit. Producing long runs of similar units has its greatest influence on cost reduction by decreasing the per-unit cost of design, increasing the efficiency of the labour force and increasing the size of material orders especially in the case of non-standard items.

Small manufacturers decrease output between November and March. Fewer orders in this season increase the overhead cost of production. Adaptation of the system described here can increase the use of the plant and permit the construction of units to coincide with field installation in early spring. Units can be stored at the plant site or loaded and shipped to the field if storage space is at a premium.

Plant production introduces an efficiency of labour not found in site construction. First, supervision in a controlled environment is superior and can accommodate a semi-skilled labour force. Second, a number of units are "on-line" simultaneously allowing a more

predictable and structured approach to organization of effort. Finally, an increase in production can be managed by increasing the number of shifts without necessitating overtime.

The size of the project affects the efficiency of site labour. Though current economic conditions have forced contractors to be most careful and efficient in assigning site labour, certain skilled tradesmen must be present to achieve a minimum quality of construction. With a smaller project each of these trades may not be employed at full capacity, though accommodation, travel time and the cost of equipment rental will remain constant. These costs must be recovered in the selling price. Minimizing site work will decrease the number of skilled tradesmen required and with a larger project, the skilled trades can be employed more effectively.

4.4.2 ASSEMBLY COMPONENTS

The overall cost of materials used in the manufacturing plant is dependent on the volume ordered, the plant's capacity for storage, and the ability to organize production to minimize waste.

Material storage is clearly easier at a factory than at a building site. The factory can take advantage of volume discounts and price fluctuations in times of heavy supply. Greater certainty of production is possible in the controlled conditions of the factory, a luxury not afforded to a builder moving from site to site, dealing with climatic changes and obstacles to delivery at particular locations. The conditions of storage are superior at the plant, decreasing the amount of waste and increasing the general quality of construction materials.

Close supervision and a systematic approach reduces the amount of material discarded during construction. This efficiency in the use of assembly components reduces the final cost to the buyer. Excess material in the field must be transported to a new site making this approach less cost effective.

Non-standard assembly components may at the outset add a premium to the factory cost. The designs presented here, in an effort to dispel the standard image of manufactured homes have used wood windows and gypsum wallboard. Site installed roofs and stucco siding are also not standard adding a labour as well as a material cost premium. The low market appeal of current manufactured product has suggested that these changes may increase the appeal of the manufactured product. Ideally, the increased volume of sales will compensate for these premium items.

The transfer of certain construction tasks to the site does not preclude factory participation in these tasks. Component parts, such as panelized basement foundations or roof trusses can be factory built and sent to the site with the unit. The plant efficiency of material use is preserved while maintaining dimensional control and reducing the potential of shipping damage to a finished product.

The conceptual approach of minimum construction and maximum assembly at the site location is fundamental to the contract documentation system. This enables the responsibility of each actor in the process to be defined with precision. Dimensional control is more certain when critical components are manufactured concurrently at the plant. Damage and warranty claims will be less frequent when finishing is completed at the final location, and with the clear documentation, any damage can be immediately assessed as construction or assembly related and the responsible party identified.

4.4.3 TRANSPORTATION

The cost of transportation is dependent on the width of the unit, the number of units transported and the contractual responsibility of the transporter.

Units less than 3700 mm (12 feet 3 inches) in width can travel on Alberta highways without an escort vehicle. Escort vehicles are available for forty cents per kilometre. This premium is substantial in the transportation of 14 and 16 foot units currently produced by single-family mobile home manufacturers though if the project is of sufficient size, a hydraulic jack truck can serve the function of escort vehicle and installation equipment. In the current system, this cost is accepted as a better alternative to co-ordinating the joining of units at the site location, a problem specifically addressed by this research. Some manufacturers have in the past used a hydraulic jack truck as a pilot vehicle. This equipment, necessary for site installations served an important role in preventing highway damage even when widths were less than the required maximum.

A minimum of four units must leave the plant-site weekly to utilize leased transportion effectively. Since most small home manufacturers are not producing this volume individual transport contracts must be arranged by the buyer or his agent. This situation leads to some problems in determining the responsibility for warranty during travel.

An increased market for the small home manufacturer will lead to a more effective system of transportation. A cost reduction of twelve percent can be realized even with a short production run of twelve modules.

Transportation is important to the system proposed here and is a vital link in the use of factory-built units. The experience of the industrial manufacturer has demonstrated the need for assigning the responsibility for transportation to a contract party, assisting project coordination and scheduling.

4.4.4 UNIT ERECTION COSTS

As a site activity, unit erection costs will comprise a large part of the final unit cost. In this system, the effectiveness of the site labour component will increase through clearly documenting the contractual responsibilities of this actor.

Key informants in the resource industry pointed out the competition that develops in the labour market when the completion of plant facilities coincides with the start of residential construction. The use of manufactured components removes a portion of the labour-intensive construction from the immediate area. The portion of work that remains can be absorbed by the indigenous semi-skilled labour force of the region. Larsen (1979) provides more detail on the phases of development supporting these comments.

In the past, some manufacturers have provided complete factory-built housing packages, including unit erection and hook-up. This comprehensive service gradually became economically uncompetitive. The apparent reasons were a limited market and a product line that was too varied. Introducing this system of documentation and management, basic unit modules remain relatively constant while site components; exterior finish, configuration and roof lines vary. The documents free the manufacturer from the responsibility of providing site crews familiar with their systems, as the new systems of installation are clearly outlined for bidding by general contractors.

It is expected that the number of units necessary for economical factory production will provide sufficient incentive and volume for competitive bids from site contractors.

Industrial housing builders found that a lack of clear supervision in contract phases led to increased warranty claims prior to approval by the client. Much of this repair could have been avoided if the site contractor and the manufacturer had documented and co-ordinated the construction sequence and the responsibility for protection of factory work during installation.

The proposed system of management is expected to reduce the time required for unit erection by providing direct lines of supervision, sequencing and control during installation and finishing.

Certain adaptations are necessary to insure that the factory building is weathertight. Schedule control in the field is not amenable to the strict controls of the plant and modules may be subject to unplanned storage in the field. Units must be fully sealed prior to shipment.

4.4.5 SITE SERVICING

As a means of reducing cost, the single family units have been designed to meet the requirements of narrow lots, decreasing the cost of servicing for each unit.

Builders in resource communities have not experienced great success with narrow lot designs. This is partially attributable to the relative cost of the housing. As a stated preference for large lots exists in resource communities, the cost of these lots must be substantially less to convince a buyer that the compromise is worthwhile. These particular units have included a secluded and private deck to compensate for the narrow lot siting and will, in

volume, exceed the minimal saving. In the production volumes expected the overall saving is expected to exceed 15 percent making the narrow lot an attractice choice.

The commitment of a major developer is paramount to the widespread use of the manufactured product. This commitment has been expressed by those currently involved in industrial development and construction as a complement to the other services they offer to resource companies.

The purchase of land and servicing of lots is not directly affected by the contract documentation. Initially, it was expected that a design-build approach to residential accommodation was attractive to resource companies. Increasingly, it appears that more control over the construction phase is desired by the company. Many of the resource companies have purchased land for residential development. A modified design-build package, including marketing and financing, and in some cases residential management appears to be a more acceptable alternative.

4.4.6 UTILITY CONNECTIONS

Utility companies have in the past restricted the development of multi-story modular buildings. As this portion of the contract must occur at the site, and requires a specialized labour component, questions of responsibility for the finishing work after the mechanical work complete may arise.

The mechanical systems required in multi-story building provide a pertinent example of the value of the contract documents. As mechanical connections must be left open for hook-up on site, the documents provide clear detailing and assignment of the work required to close the pipe chases once the mechanical work has been completed. This clarity increases the potential for use of standard modules in many building types.

Modular units must be manufactured to insure weathertightness during storage and transport. This results in a measure of construction redundancy not associated with site-built construction. The roof of each module must provide support for ceiling finishes as well as provide a minimal level of protection against the elements. Plant labour, and the efficiency of the manufacturing process has generally been thought to be sufficient to offset the redundancies.

While this study neither confirms, nor denys, this claim, the redundancies create certain opportunities in stacked module construction. Sprinkler piping, ventilation ducts, supply and return air can be conveniently located within the design of the standard module.

The effect of structurally-borne noise transmission from floor to floor can be reduced by taking advantage of the redundancies of modular construction. It may result in stacked modular construction becoming a method preferred over traditional construction forms from a qualitative viewpoint.

4.5 COST COMPARISONS

The unit designs presented in this report compare favourably in cost, aesthetics and quality to the standard products of the manufacturers in this province. The single-family units show a price advantage of 11% - 17% over comparable units constructed on site. This is comparable to savings reported in the literature. The length of the production run necessary to achieve a minimum economy of scale was applied in this estimate. A larger project and increased familiarity with this new approach could be expected to lower the cost of each unit.

Most manufacturers would counter this suggestion of success with the claim that any increase in the length of a production run will reduce the cost of their product. This claim is not disputed, despite the slight price advantage these units have over the current manufactured product. The value of this system extends beyond the reduction in the end price of the unit. This value will be discussed below.

In "camp accommodation", the cost comparison raises some pertinent issues. The caution apparent in the manufacturer's estimates clearly demonstrates co-ordination difficulties that the manufacturer expects in sub-contracting a large portion of the site work. The clarity of the documentation provided by this system is necessary to improve the relationship and co-operation between factory builders and site contractors by clearly defining the responsibilities from the outset.

Industrial manufacturers, like their single-family counterparts, can be criticized for restricting their market by concentrating on their product output rather than the potential of the factory process. Difficulties arise when designs call for variations from the standard modular output. In this case, it appeared that the design variations were estimated at a premium cost added to the price of the standard factory module. Secondly, the desire to maximize factory output may have influenced the approach in considering the most cost-effective building system to satisfy the particular requirements of this unique design concept. This attitude is understandable in light of the present economy, but essentially a significant block to adapting the factory process to a greater range of building types. Finally, in an effort to maintain the market for on-site accommodation in resource areas, the manufacturer must expand beyond the expertise necessary in the installation of the traditional camp unit. This includes permanent foundations for multi-story buildings, continuous siding and site installed roof systems. In this initial estimate, it is apparent that these issues had some effect on the estimated costs provided by the manufacturers.

Panelized construction is not widely used in this area and only a general comparison is possible. Recent research indicates that this method of construction returns a cost of $35.00 - $40.00 per square foot. These savings derive from economies in materials and shipping. Labour and assembly costs remain similar to those of stick building and will be reflected in the unit cost.

4.6 OTHER COMPARATIVE ISSUES

The use of this system of contract documentation increases the design flexibility of the home manufacturer. Difficulties in dimensional control, product damage and installation have deterred the growth of the market for double-wide units. As a compromise, the width of single wide trailers has increased from twelve to fourteen and sixteen feet. These widths are difficult and costly to transport, and severely restrict the choice of potential buyers. With the use of co-ordinated documentation provided by the contract system, manufacturers can confidently participate in a wide range of residential projects. Dimensions will be matched to the drawings provided, work will be completed by each contractual party assigned at the outset of construction, and warranty claims will be assigned to the party responsible for the particular aspect of the work.

One of the issues identified by Reed Management (1982) was the large number of models produced by manufacturers. This approach to attract a larger portion of the market may be more successful if model variations are added in site construction and the continuity of module production is maintained in the factory. The desire for buyer adaptation and finishing options were discussed as a marketing advantage in resource community housing. The factory process can with this system of contract documents, streamline the output of the assembly line. Variation can be maintained in the work of the site contractors or the buyer who wishes to participate in finishing the unit to reduce the initial cost.

Most manufacturers will counter this advantage with the claim that, with the exception of roof pitches, a factory produced unit can mimic a site-built unit. While this is true in theory, the problem remains in assessing the actual market value of final completion of a unit in the factory. Dimensional restrictions will always exist on unit heights, one of the identifiable image deterents. Full finishing of units at the factory also exposes the tranporter and crew to more liability for damage in shipping and installation. If units are fully weatherproofed for shipment and finished at the site some tolerance is available.

Manufacturers have spent time and money pursuing aesthetic compromises in an effort to expand their market. This research provides a means of appealing to a larger market using standard modules, the greatest advantage of assembly line production.

Much of the discussion of the single-family comparison applies to industrial housing. The major difference is the control that manufacturers have maintained in the industrial housing market with little interference from stick-builders. Current market conditions and a change in the attitude towards the 'temporary' nature of the accommodation appear to be challenging this monopoly.

Initially, this report presented a new concept in on-site labour accommodation, one being considered by resource companies whose sites are greater than 1.5 hours commuting distance from settled communities.

It is important to develop a modular concept based on the envisioned quality of these "hotel-like" structures within the budgetary restrictions of a resource company market.

The design presented in this report is an intermediate step on the qualitative scale, but demonstrates the factory capacity to participate in competition with "stick-builders". This co-operation is subject to the introduction of the contract documentation and management system that allows each contract party to participate with full knowledge of their assigned responsibility.

Comparison to traditional camps can be made on both a qualitative and cost basis. The former is not independent of the latter, but raises some issues for discussion.

Manufacturers, while interested in increasing their market, are not totally familiar with the construction alternatives that may include factory modules.

A traditional 400 man residential camp can be manufactured and installed for approximately four thousand dollars per unit. This traditional camp would consist of ten forty-two room modules, with room sizes of approximately 80 square feet, common shower and water closet facilities, vinyl flooring and walls, installed on piles at site. The alternative presented here was estimated to be three times this cost but included semi-private bath and water closets, furnishings, carpeted floors and rooms of 112 square feet in 12 room modules. Construction of this alternative by a "stick-builder" was estimated at slightly less than twice the price of the traditional camp.

The traditional camp is temporary in nature. The alternative proposed in this study has an intended 25 year life span, offsetting the additional capital cost. Lower maintenance and operational costs over the building's life span increase the attractiveness of this alternative.

CHAPTER 5 - SUMMARY AND CONCLUSIONS

The contract documentation and management processes discussed in this report address many of the issues that constrain the market share of manufactured house builders.

The documents integrate the construction process from design to turnover, emphasizing the co-ordination necessary in the manufactured home industry to participate in large projects in the resource sector. It is evident that the industrial camp builders have made some steps toward this co-ordination to maintain their market share. While supporting the hypotheseis, these primary steps expose the difficulties that arise without contract documents developed to insure positive co-operation between the factory and site builders throughout the contract period. Especially critical, is the caution in price esimates indicated in this research.

Manufacturers have traditionally operated independently. Actions to integrate with developers or in project management proposals may be slow. The capital cost of entry into manufacturing is low, a consideration that may encourage the development industry to bypass established manufacturers if they demonstrate any hesitance in joining forces. Until initial projects are completed, it is difficult to predict exactly the influence of this form of documentation and management on the caution exhibited in the cost estimates presented here.

The documentation system clearly expands the ability to understand the manufactured home as a complete entity rather than a linear progression of separate actions by related operators. Given the comprehensive nature of the information, one actor, be it developer, contractor, manufacturer or dealer, has the potential to co-ordinate all parts of the process subcontracting each service as required. This reduction in the number of independent contracts may serve to reduce the final cost of the unit to the buyer.

The satisfaction available to the consumer in the resolution of guarantee and warranty work can be improved in this integration. The clear assignment of responsiblity offers the buyer a significant advantage in identifying a course of action for the repair of defects in the unit.

Reed Management (1982) discussed the large number of models produced by manufacturers in response to a highly competitive market. This approach reduces the primary advantage of manufacturing that is the economy available in increasing the size of production run. The integration of site-finishing will transfer many of the tasks associated with diversity to the site, that is exterior siding, and landscaping and/or interior painting. In addition, the comprehensive nature of the system allows site built roofs which further increase the curb appeal of the house. Most important in this approach is the attitude that factory building is a process and not the single means of arriving at a product. This point is significant in the development of

an appropriate response to the large market available in resource communities.

The specific housing needs of resource community residents are discussed at length by Praxis (1982) and reviewed in Chapter 1. There is no doubt, that the cost of accommodation in resource communities is a primary deterrent for many residents who desire single family accommodation. The low cost of labour and better use of materials in the factory, in concert with an increase in production to offer an economy of scale; for factory overhead, unit erection and site finishing costs; provides the potential to overcome this financial deterrent. The final product will offer the high quality of factory construction, free of many of the image problems present in the traditional manufactured house. This accommodation operation, presently available to resource community residents, has not appealed to a significant number.

The importance of the contract documents cannot be denied in supporting increased co-ordination and co-operation within the industry and between factory builders and site builders. The clarity of the system offers developers the information they require to introduce the manufacturing process into large scale residential projects. The experience of this sector of the industry is mandatory if manufacturers are to participate in projects of this size.

The introduction of a new aesthetic to 'camp accommodation' is timely. The contact of the research team with the marketplace has indicated strong support from both resource companies and unions that a change from the traditional forty-two man trailer to more individualized units is imminent. The review of the construction camp guidelines in 1985 is expected to introduce more restrictive design directives for labour accommodation.

There is support for the hypothesis that the traditional manufactured unit is no longer exclusively appropriate to the needs of resource companies. The camp configuration developed here makes a step towards the accommodation described in the first chapter of this report. It indicates the realization that much of the industrial accommodation installed as "temporary quarters" at resource extraction sites is as permanent as the extraction and refining equipment.

Since the inception of the project, virtually every resource company has expressed interest in the camp accommodation, either due to the remote location of their sites or simply as an alternative to the local hotel accommodation which adds a cost premium, especially in periods of plant construction, and the resulting heavy demand on the small offering of rural communities.

The primary advantage to camp design, arises from a new relationship between manufacturers and site builders allowing a co-ordination of their respective building processes. This team effort can use the cost-effectiveness of factory buildings and the long accepted aesthetic of site building to achieve a design product of quality. Achieving

this product, acceptable to town and city regulators and the buying public, is fundamental to expanding the market of home manufacturers.

Many manufacturers are convinced that these changes will adversly affect their current market position. Their claim is that their market will expand if the manufactured home is treated as a permanent home with the associated titles to land ownership. It is apparent that a large portion of the traditional market were attracted by low cost and ease of procurement. This supports the survival of the manufactured home in rural areas.

The contract documentation system proposed in this research addresses the difficulties experienced by the manufacturer in co-ordinating with other actors in the construction industry. This will clear the way for innovation in design and lower costs that will appeal to a larger portion of the accommodation market. This portion was apparently not willing to compromise their image of a permanent home in purchasing a traditional manufactured unit. The potential offered in participating in a process that will produce a product of equal aesthetic of a stick built unit is fully available.

Other benefits of co-ordination through this contract documentation are:

1. Allowing the designer to understand the limiting constraints of the factory process and compensate for these.

2. The opportunity for factory builders to develop long-standing relationships with site builders to reinforce their construction strengths.

Although theoretically these changes in the system appear timely and inevitable, there will be little doubt that they will be met with resistance from the construction industry. The stick-built contractor and the construction labour unions have a vested interest in maintaining a labour intensive industry. The labour intensiveness does not decrease in the plant though the level of skill required results in an average wage rate that is much lower than on-site construction. This will undoubtedly be a negative factor in the acceptance of this approach.

At the outset, familiarity with different portions of the work may influence the bidding process. This will appear mostly in the traditional tender where sub-contracts will be bid at the discretion of the general contractors or the manufacturers. The uncertainty may result in the major contractors' presumed ability to control the situation, or the problems forseen in site co-ordination.

In light of these comments, a project management or design build system of contract implementation appear to be the best complement to the proposed system of contract documentation.

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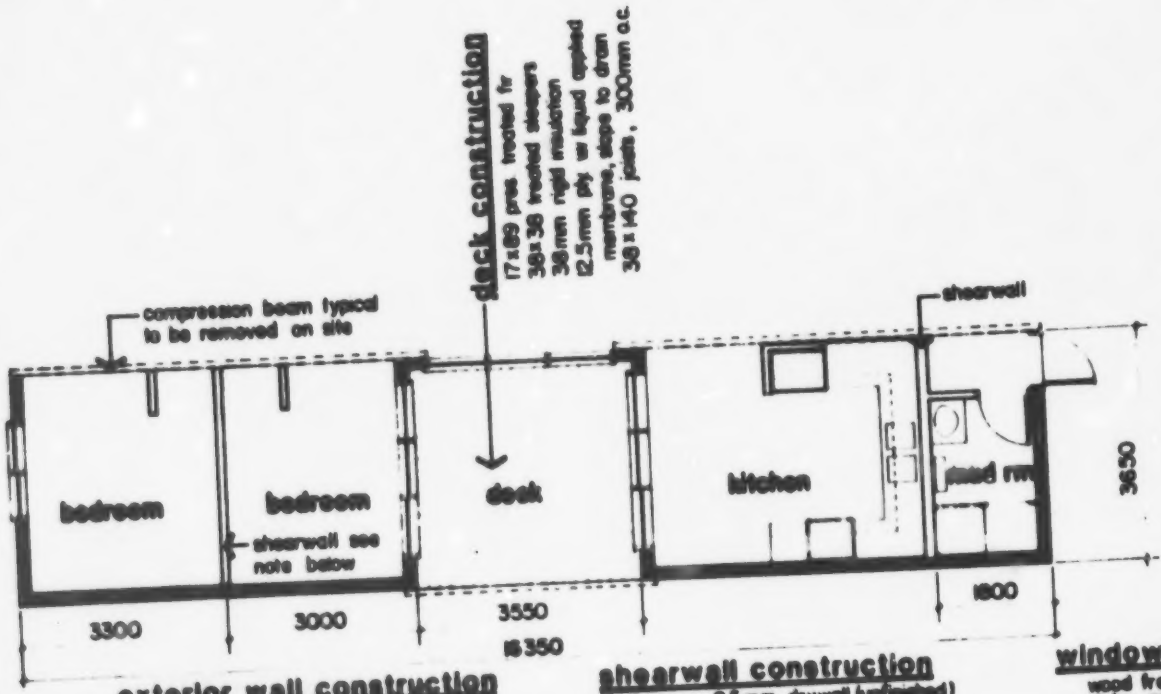
APPENDIX I

A. SCOPE OF WORK DRAWINGS: SINGLE FAMILY HOUSING

The drawings presented here represent the documents provided to site contractors and manufactured housing builders to obtain initial price estimates. While not a complete set of documents, they serve to illustrate the separate components of factory and site building and the information necessary for each builder.

CONTENTS

Volume	Sheet	Title
1	1	Module A.12
1	2	Module A.14
1	3	Module B.12
1	4	Module B.14
1	5	Module C.12
1	6	Module C.14
1	7	Module Location Plan A
1	8	Module Location Plan B
1	9	Module Location Plan C
2	10	Site Construction Plan A
2	11	Site Construction Plan B
2	12	Site Construction Plan C
2	13	Section A
2	14	Section B
2	15	Section C
2	16	Elevation A
2	17	Elevation B
2	18	Elevation C



exterior wall construction

15 mm plywood sheathing
R 30 batt insulation
38 x 140 studs, 400 o c
polyethylene vapour barrier
2 layers 9.5mm drywall
(untaped, no paint)

interior wall construction

38 x 89 studs, 400 o c
2 layers 9.5mm drywall both sides (untaped no paint)

shearwall construction

2 layers 9.5mm drywall (unfinished)
38 89 studs, 400 o c
9.5mm plywood screwed to studs
9.5mm drywall (untaped, no paint)

doors

exterior doors
solid core birch c/w hardware
screened storm door

interior doors
pre-hung hollow core birch

patio doors
sealed units c/w slider, screen

windows

wood frame sealed units c/w slider and screen, vinyl clad

floors

sheet vinyl (3 color choice)
carpet (3 color choice

kitchen

hardwood frames and fronts
moulded plastic lam countertop
stainless steel sink

bath

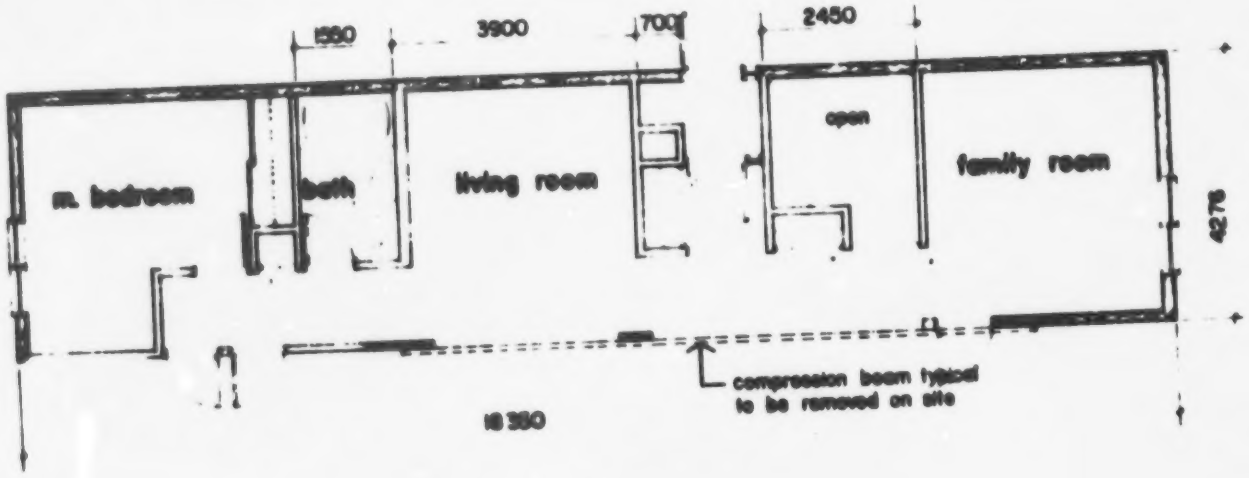
hardwood vanity with plastic lam. top
ceramic tile (alternate fiberglass tub & and plumbing installed for site hook-up

74

MODULE A·12

VOLUME 1 UNIT 1

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



exterior wall construction

15 mm plywood sheathing
R-30 batt insulation
38 x 140 studs, 400 o.c.
polyethylene vapour barrier
2 layers 9.5mm drywall
(untaped, no paint)

interior wall construction

38 x 89 studs, 400 o.c.
2 layers 9.5mm drywall both
sides (untaped no paint)

shearwall construction

2 layers 9.5mm drywall (unfinished)
38 89 studs, 400 o.c.
9.5mm plywood screwed to studs
9.5mm drywall (untaped, no paint)

doors

exterior doors
solid core birch c/w hardware
screened storm door
interior doors
pre-hung hollow core birch
patio doors
sealed units c/w slider, screen

windows

wood frame sealed units c/w
slider and screen, vinyl clad

floors

sheet vinyl (3 color choice)
carpet (3 color choice

kitchen

hardwood frames and fronts
moulded plastic lam. countertop
stainless steel sink

bath

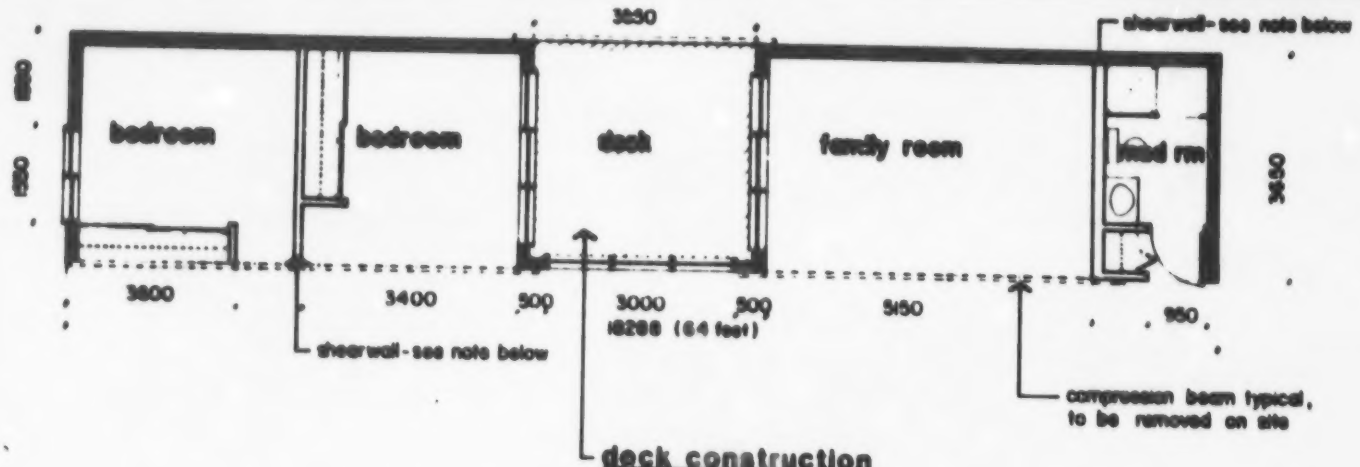
hardwood vanity with
plastic lam. top
ceramic tile (alternate
fiberglass tub & unit
plumbing installed for
site hook-up

75

MODULE A-14

VOLUME 1 SHEET 2

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



deck construction

17 x 89 pres treated fir
38 x 38 treated sleepers
38 mm rigd insulation
12.5mm ply w liquid applied membrane, slope to drain
38 x 140 joists, 300mm o c

exterior wall construction

7.5 mm plywood sheathing
R-30 batt insulation
38 x 140 studs, 400 o.c.
polyethylene vapour barrier
2 layers 9.5mm drywall (untaped, no paint)

interior wall construction

38 x 89 studs, 400 o.c.
2 layers 9.5mm drywall bath sides (untaped no paint)

shearwall construction

2 layers 9.5mm drywall (unfinished)
38 89 studs, 400 o c
9.5 mm plywood screwed to studs
9.5 mm drywall (untaped, no paint)

doors

exterior doors
solid core birch c/w hardware
screened storm door
interior doors
pre-hung hollow core birch
patio doors
sealed units c/w slider, screen

windows

wood frame sealed units c/w slider and screen, vinyl clad

floors

sheet vinyl (3 color choice)
carpet (3 color choice

kitchen

hardwood frames and fronts
moulded plastic lam. countertop
stainless steel sink

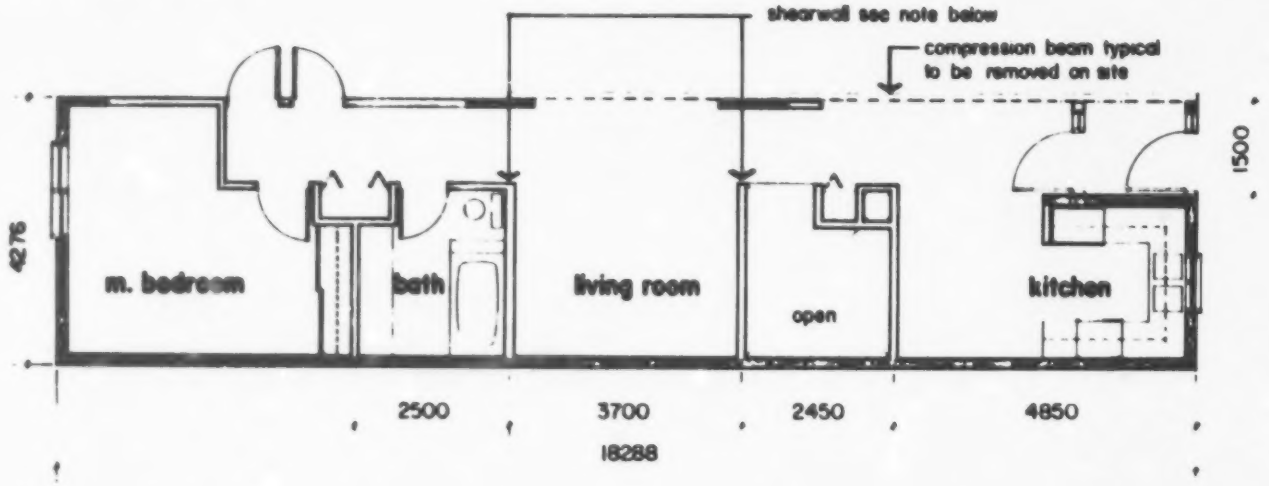
bath

hardwood vanity with plastic lam. top
ceramic tile (alternate fiberglass tub & end.
plumbing installed for site hook-up

MODULE B-12

VOLUME 1 SHEET 3

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



exterior wall construction

75 mm plywood sheathing
R 30 batt insulation
38 x 140 studs, 400 o c
polyethylene vapour barrier
2 layers 9.5mm drywall
(untaped, no paint)

interior wall construction

38 x 89 studs, 400 o c
2 layers 9.5mm drywall bath
sides (untaped no paint)

shearwall construction

2 layers 9.5mm drywall (unfinished)
38 89 studs, 400 o c
9.5mm plywood screwed to studs
9.5mm drywall (untaped, no paint)

doors

exterior doors
solid core birch c/w hardware
screened storm door
interior doors
pre-hung hollow core birch
patio doors
sealed units c/w slider, screen

windows

wood frame sealed units c/w
slider and screen, vinyl clad

floors

sheet vinyl (3 color choice)
carpet (3 color choice

kitchen

hardwood frames and fronts
moulded plastic lam countertop
stainless steel sink

bath

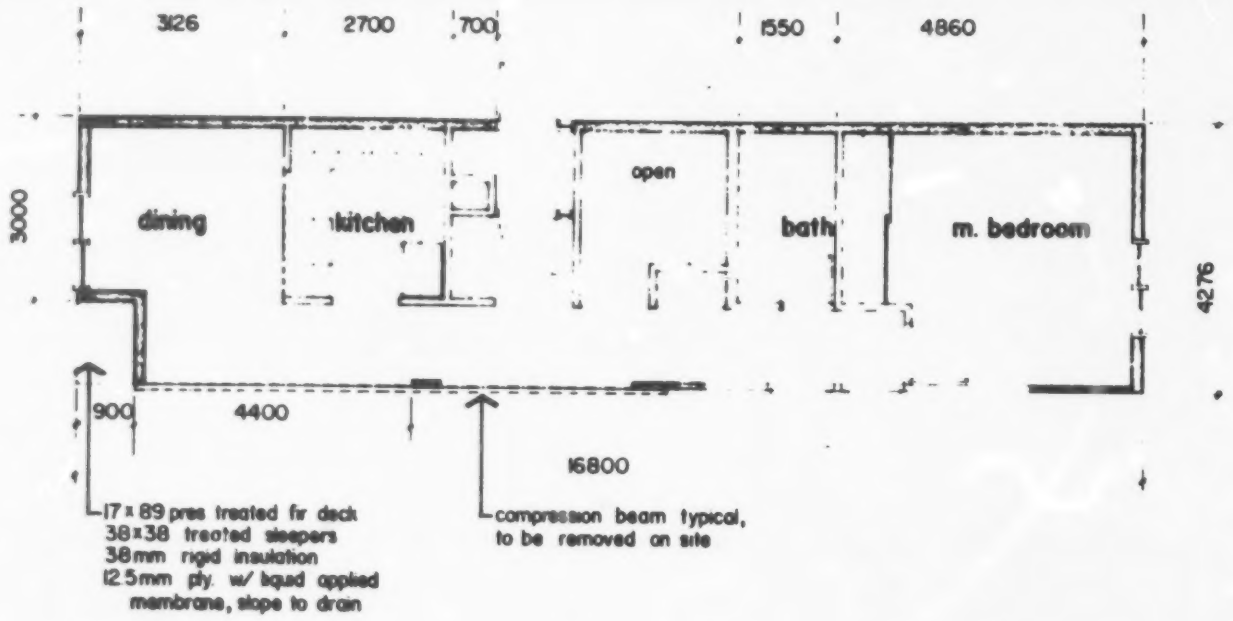
hardwood vanity with
plastic lam top
ceramic tile (alternate
fiberglass tub & end
plumbing installed for
site hook-up

MODULE B-14

VOLUME 1 SHEET 4

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

terry c frost
architect ltd.



78

exterior wall construction

7.5 mm plywood sheathing
R-30 batt insulation
38 x 140 studs, 400 o.c.
polyethylene vapour barrier
2 layers 9.5mm drywall (untaped, no paint)

interior wall construction

38 x 89 studs, 400 o.c.
2 layers 9.5mm drywall both sides (untaped no paint)

shearwall construction

2 layers 9.5mm drywall (unfinished)
38 89 studs, 400 o.c.
9.5mm plywood screwed to studs
9.5mm drywall (untaped, no paint)

doors

exterior doors
solid core birch c/w hardware
screened storm door
interior doors
pre-hung hollow core birch
patio doors
sealed units c/w slider, screen

windows

wood frame sealed units c/w slider and screen, vinyl clad

floors

sheet vinyl (3 color choice)
carpet (3 color choice

kitchen

hardwood frames and fronts
moulded plastic lam. countertop
stainless steel sink

bath

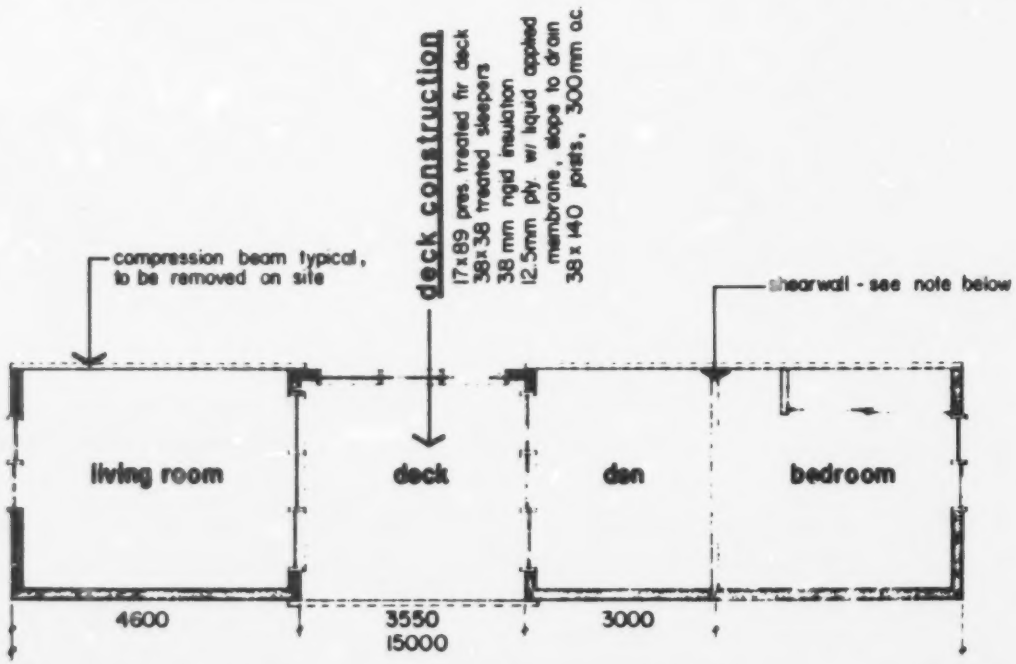
hardwood vanity with plastic lam. top
ceramic tile (alternate fiberglass tub & end.
plumbing installed for site hook-up

MODULE C-14

VOLUME 1 SHEET 5

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

gary c frost limited



64

exterior wall construction

7.5 mm plywood sheathing
R-30 batt insulation
38 x 140 studs, 400 o.c.
polyethylene vapour barrier
2 layers 9.5mm drywall (untaped, no paint)

interior wall construction

38 x 89 studs, 400 o.c.
2 layers 9.5mm drywall both sides (untaped no paint)

shearwall construction

2 layers 9.5mm drywall (unfinished)
38 89 studs, 400 o.c.
9.5mm plywood screwed to studs
9.5mm drywall (untaped, no paint)

doors

exterior doors
solid core birch c/w hardware
screened storm door

interior doors
pre-hung hollow core birch

patio doors
sealed units c/w slider, screen

windows

wood frame sealed units c/w slider and screen, vinyl clad

floors

sheet vinyl (3 color choice)
carpet (3 color choice

kitchen

hardwood frames and fronts
moulded plastic lam. countertop
stainless steel sink

bath

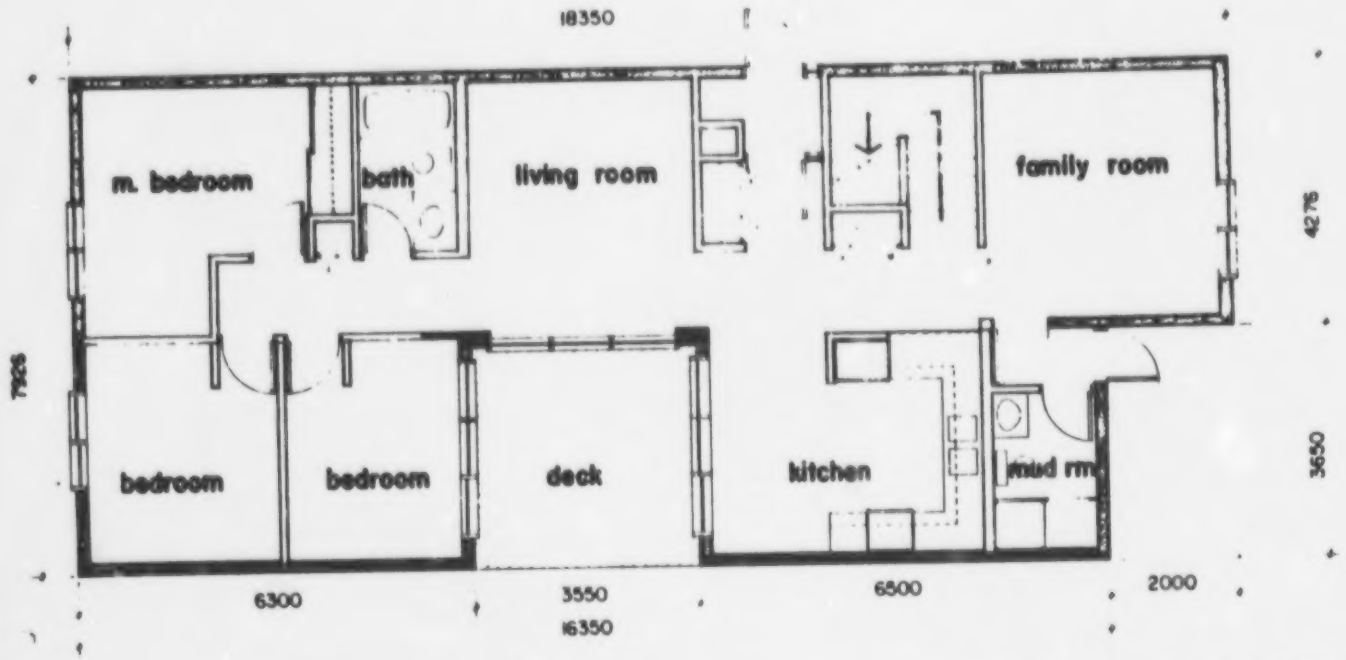
hardwood vanity with plastic lam. top
ceramic tile (alternate fiberglass tub & end.
plumbing installed for site hook-up

MODULE C-12

VOLUME 1 SHEET 6

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

terry c frost
architect



note stair to basement shown for clarity, as site-built item see sheet 10 volume 2

80

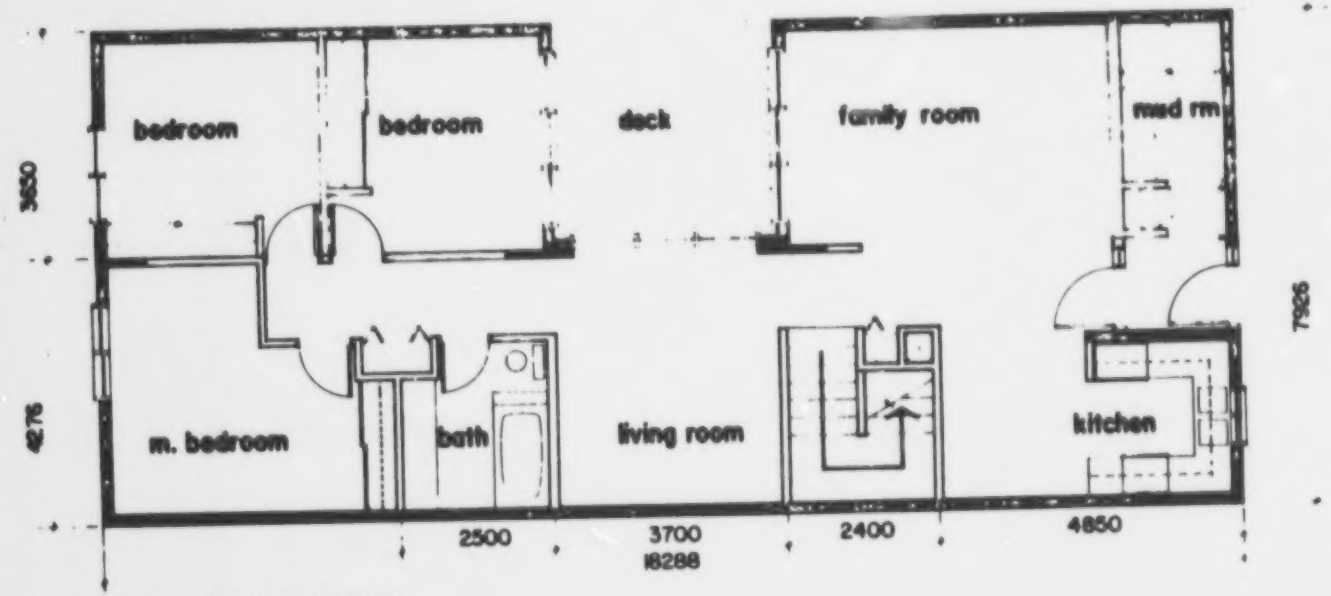
module A-12, and module A-14 combine to form unit A

MODULE LOCATION PLAN UNIT •A•

VOLUME 1 SHEET 7

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

gary c frost architect



module B-12, and module B-14 combine to form unit B

note slav to basement show for clarity, as site-built item see sheet 11 volume 2

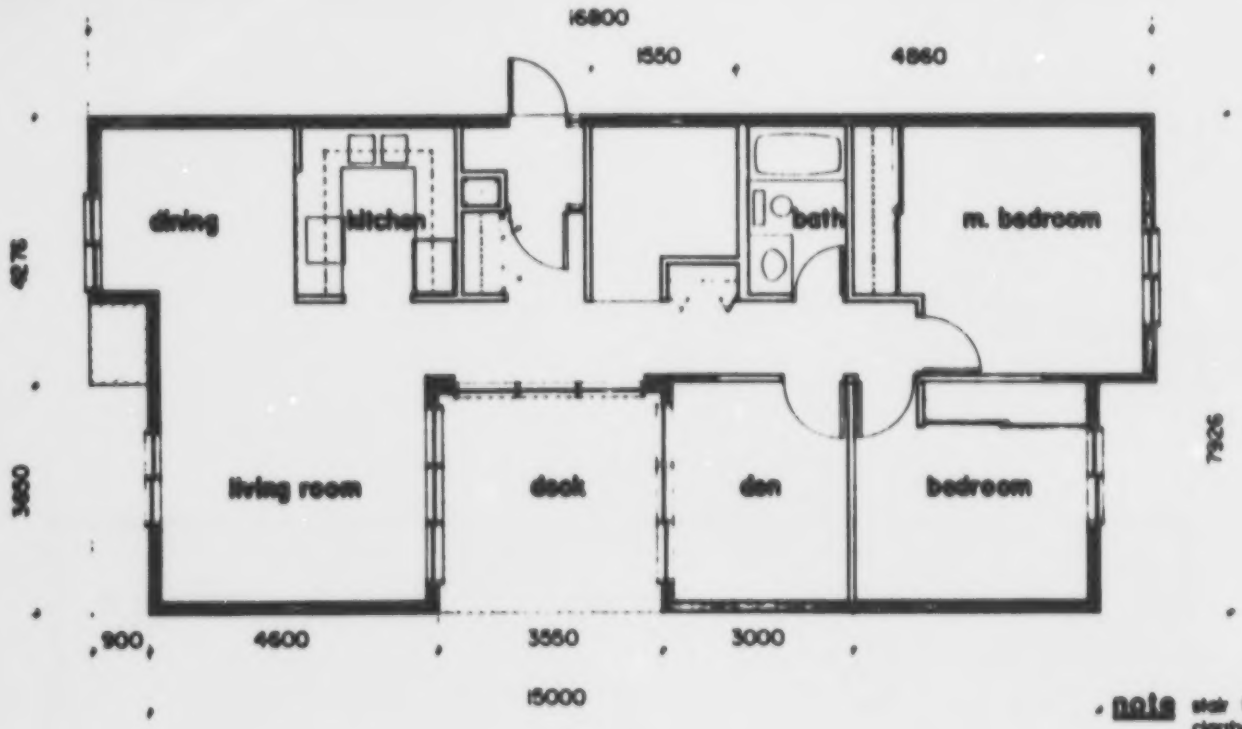
81

MODULE LOCATION PLAN UNIT • B

VOLUME 1 SHEET 8

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

c frost



module C-12, and module C-14 combine to form unit C

note stair to basement shown for clarity, as site-built item see sheet 12 volume 2

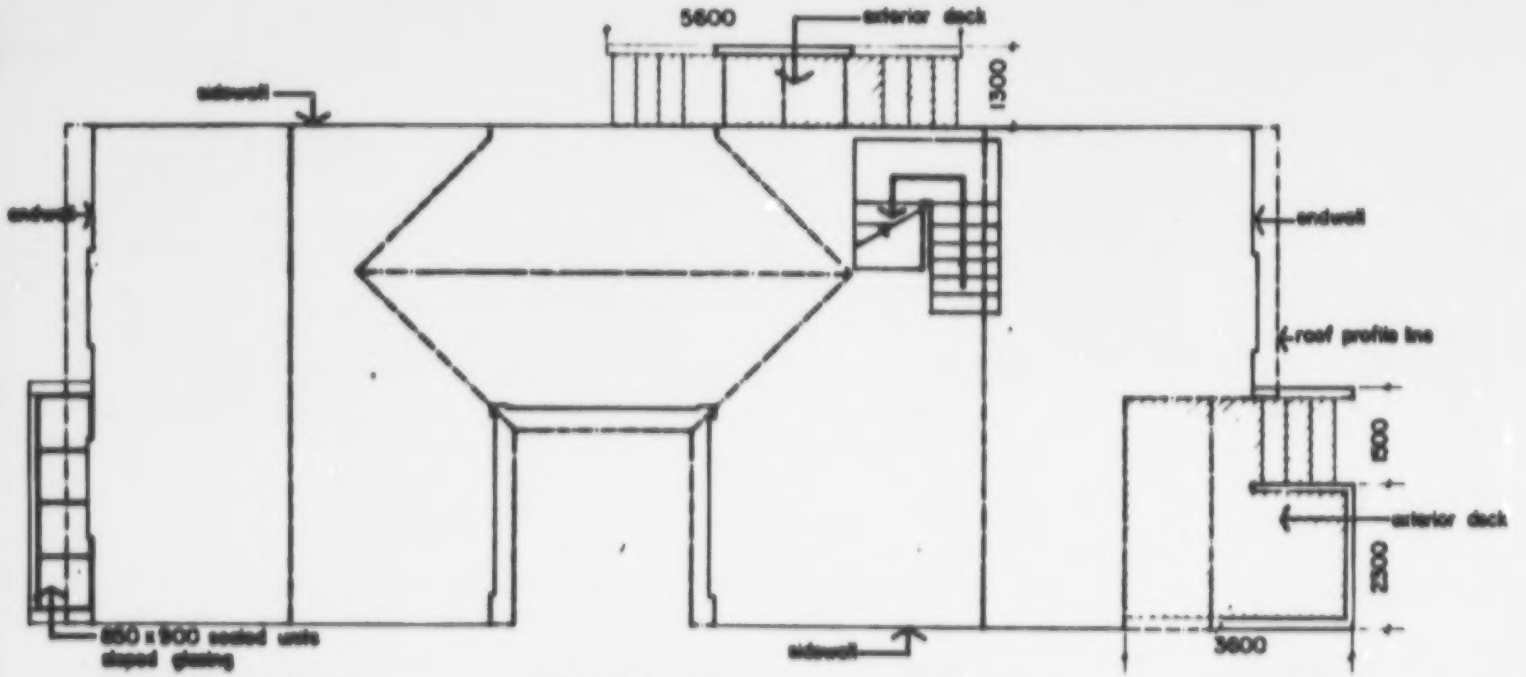
82

MODULE LOCATION PLAN UNIT • C

VOLUME 1 | SHEET 9

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

c frost associates



roof construction

asphalt shingles
10mm ext grade plywood sheathing
engineered roof trusses, 600mm o.c
38 89 No 2 or fir or better
RSI-7 blown cellulose insulation
see note 1

sidewall finish

asphalt felt building paper
stucco wire
cement stucco scratch coat
sprayed stucco final coat
c/w blueprint colorant

endwall finish

asphalt felt building paper
prefinished aluminum siding
400mm sacred profile

exterior decks

17 89 pres treated fir deck
38 235 joists 400mm o.c
built-up beams as required
on 200mm dia piles
38 89 and 38 140 studs
c/w sheathing and stucco
to match sidewall finish

note 1

casing vapour barrier - factory
installed membrane as weather
protection during storage and
transport

note 2

interior factory drywall finish
suitable for site finishing
walls - patch, tape, prime
2 coats eggshell enamel
ceilings - patch, fill and tape
spray-tex finish

note 3

shaded area shows
modular construction
shown thus

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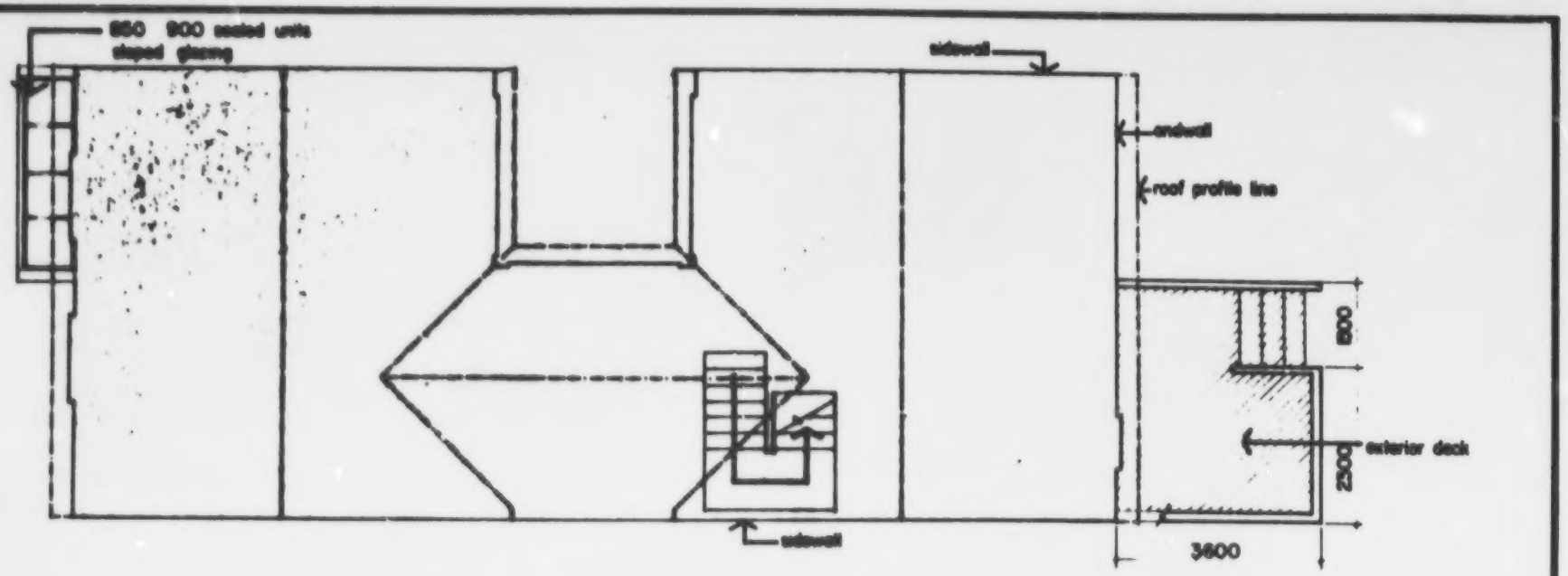
SITE CONSTRUCTION PLAN • UNIT A

VOLUME 2 SHEET 10

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



roof construction

asphalt shingles
12mm ext grade plywood sheathing
approved roof trusses, 600mm o.c.
38 89 No.2 or fir or better
RSI-7 blown cellulose insulation
see note 1

sidewall finish

asphalt felt building paper
stucco wire
cement stucco scratch coat
sprayed stucco final coat
c/w integral colorant

endwall finish

asphalt felt building paper
prefinished aluminum siding
400mm scored profile

exterior decks

17 89 pres. treated fir deck
38 235 joists 400mm o.c.
built-up beams as required
on 200mm dia. piles
38 89 and 38 140 studs
c/w sheathing and stucco
to match sidewall finish

note 1

ceiling vapour barrier - factory
installed membrane as weather
protection during storage and
transport

note 2

interior factory drywall finish
suitable for site finishing
walls - patch, tape, prime
2 coats eggshell enamel
ceilings - patch, fill and tape
spray-tex finish

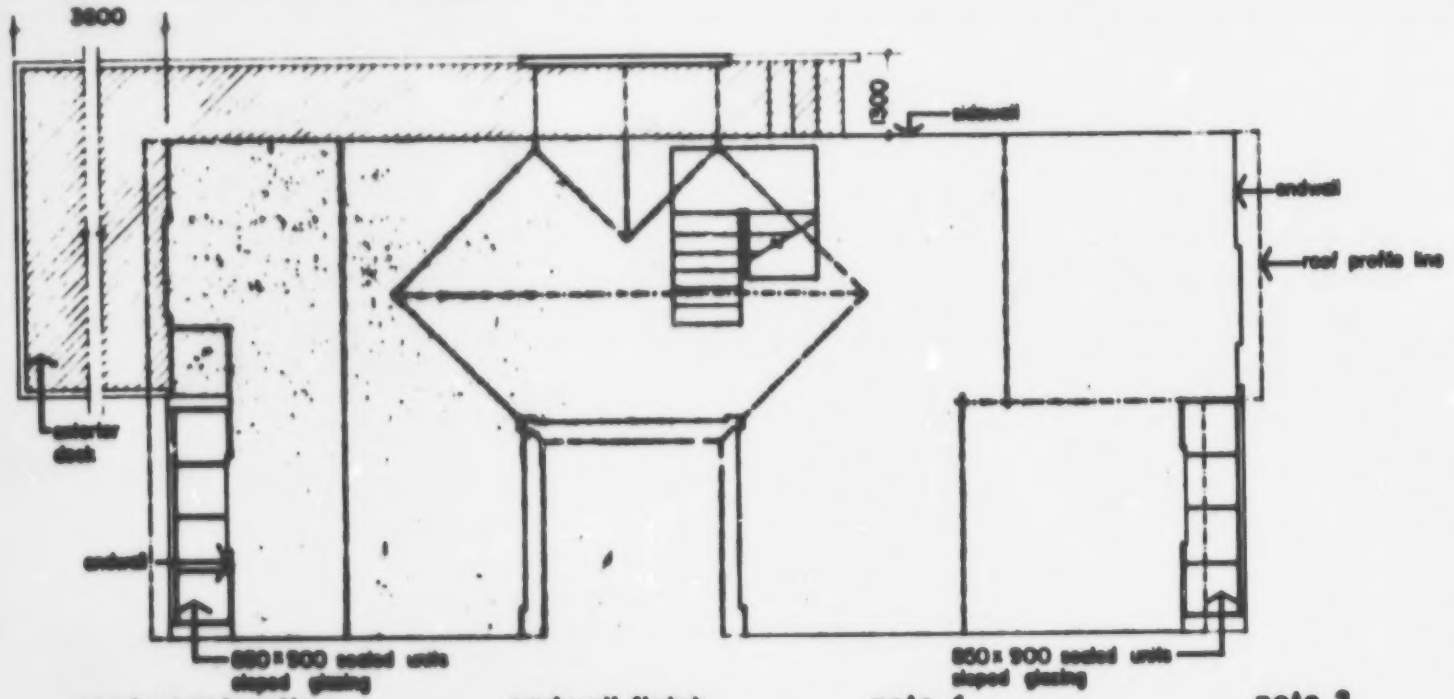
note 3

shaded area shows
modular construction
shown thus:

SITE CONSTRUCTION PLAN UNIT • B

VOLUME 2 SHEET 11

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



roof construction

asphalt shingles
12mm ext. grade plywood sheathing
sprayed cell insulation, 600mm o.c.
38 89 No.2 or fir or better
RSI-7 blown cellulose insulation
see note 1

sidewall finish

asphalt felt building paper
stucco wire
cement stucco scratch coat
sprayed stucco final coat
ovw interpret sidewall

endwall finish

asphalt felt building paper
prefinished aluminum siding
400mm spaced profile

exterior decks

17 89 pres. treated fir deck
38 235 joists 400mm o.c.
built-up beams as required
on 200mm dia. piles
38 89 and 38 140 studs
ovw sheathing and stucco
to match sidewall finish

note 1

ceiling vapour barrier - factory installed membrane as weather protection during storage and transport

note 2

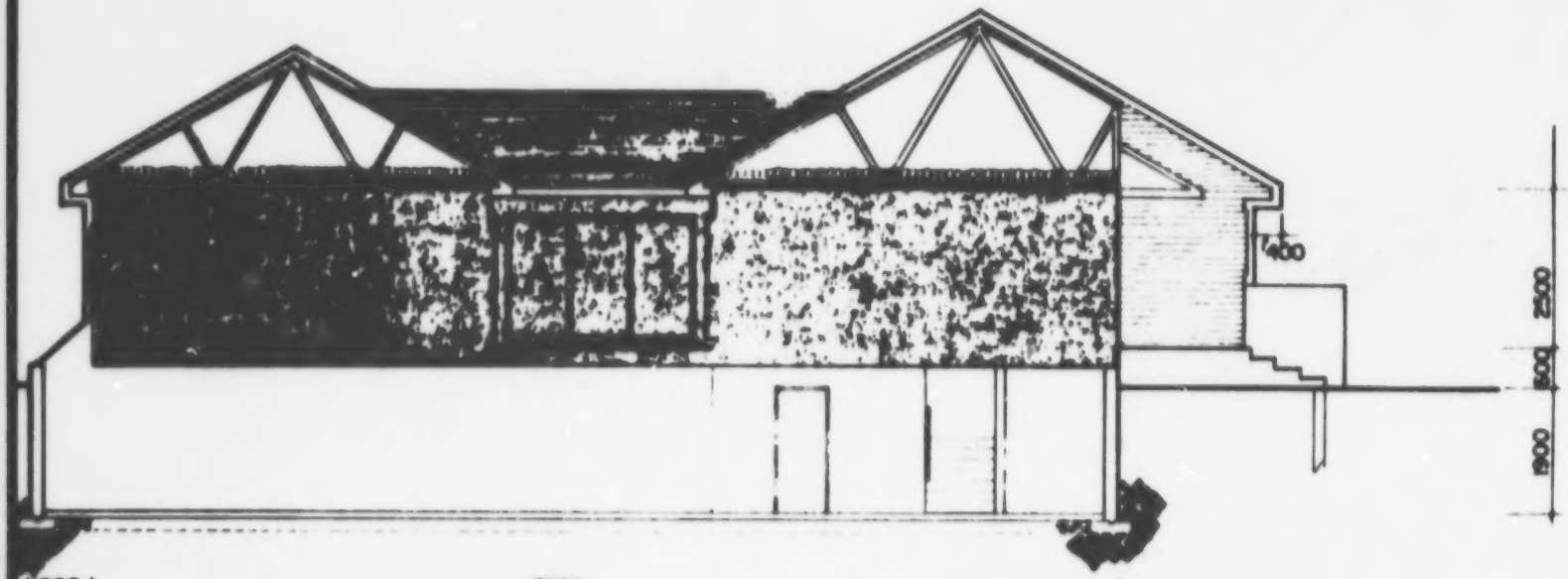
interior factory drywall finish suitable for site finishing
walls - patch, tape, prime
2 coats eggshell enamel
ceilings - patch, fill and tape
spray-tex finish

note 3

shaded area shows modular construction shown thus:

SITE CONSTRUCTION PLAN UNIT - C

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



basement walls

2 layers damproofing
R-20 rigid insulation
200 mm concrete reinforced
200 x 400 rebf conc footing
100 mm plastic weeping tile
300 mm crushed gravel

basement floor

100mm concrete floor
polyethylene vapour barrier
200 mm gravel bed

stairs

[illegible] stairs - 4 x 150 mm risers
3 x 400 mm treads
pressure treated fir

basement - 38 x 235 stringers
14 x 171 mm risers
12 x 300 mm treads
1000 x 2250 landing
50 mm railing

note:

[illegible] denotes factory construction
see volume I

misc. metal

treads - 25 x 140 mm spruce board
prefinished aluminum

rails - prefinished alum. perforated

sweatmesh & diamond - prefinished aluminum

flashings - galvanized steel

NOTE : for roof construction
see sheet 2-10

SITE CONSTRUCTION SECTION UNIT A

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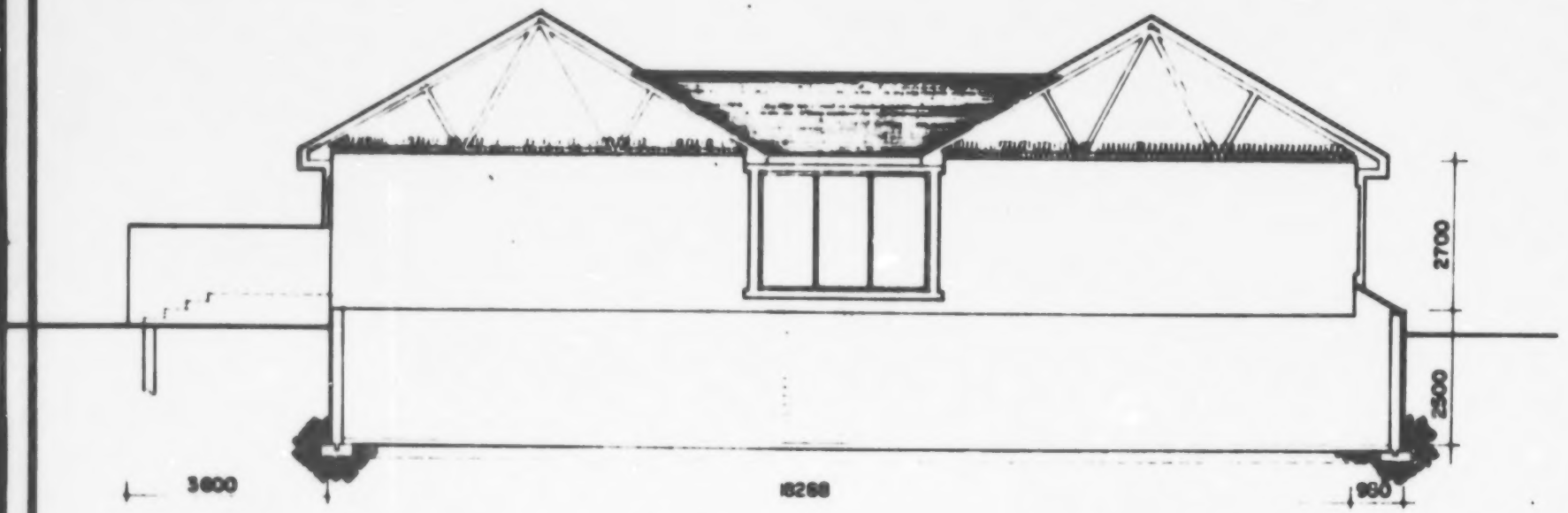
2	13	SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



basement walls

2 coats damproofing
R 20 rigid insulation
200 mm concrete reinforced
200 x 450 reinf conc footing
100 mm plastic weeping tile
300 mm crushed gravel

basement floor

100mm concrete floor
polythylene vapour barrier
300 mm gravel bed

stairs

front steps - 4 x 150mm risers
3 x 400mm treads
pressure treated fir

basement - 38 x 235 stringers
14 x 171mm risers
12 x 300 mm treads
1000 x 2250 landing
50 mm railing

note:

▭ denotes factory construction see volume I

misc. metal

fascia - 25 x 140 mm spruce board prefinished aluminum

soffit - prefinished alum. perforated

weatherstrip & flashing - prefinished aluminum

flashings - galvanized steel

NOTE: for roof construction see sheet 2-11

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SITE CONSTRUCTION SECTION UNIT B

VOLUME 2 SHEET 14

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

basement walls
2 coats dampproofing
R 20 rigid insulation
200 mm concrete reinforced
200 x 400 reinf conc footing
100 mm plastic weeping tile
300 mm crushed gravel

basement floor
100mm concrete floor
polyethylene vapour barrier
200 mm gravel bed

stairs
front steps - 4 x 150mm risers
3 x 400mm treads
pressure treated fir
basement - 38 x 235 stringers
14 x 171mm risers
12 x 300 mm treads
1000 x 2250 landing
50 mm railing

note:
▭ denotes factory construction see volume I

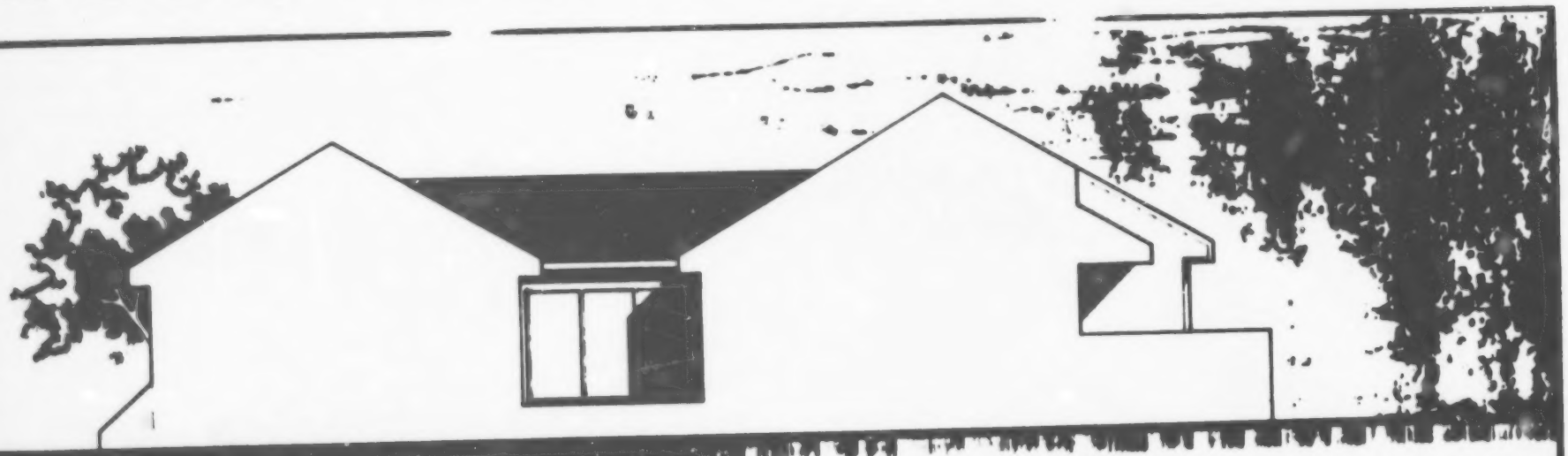
misc. metal
fascia - 25 x 140 mm spruce board prefinished aluminum
soffit - prefinished alum. perforated
eavestrough & downspout - prefinished aluminum
flashings - galvanized steel
NOTE for roof construction see sheet 2 12

SITE CONSTRUCTION SECTION UNIT C

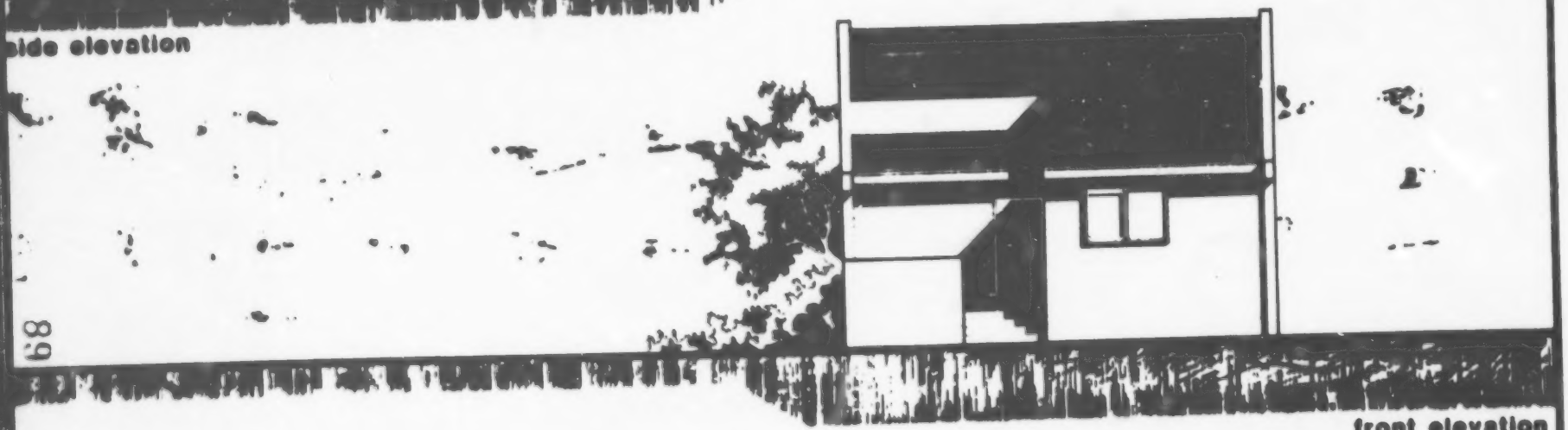
VOLUME 2 SHEET 15

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

c.frost



side elevation

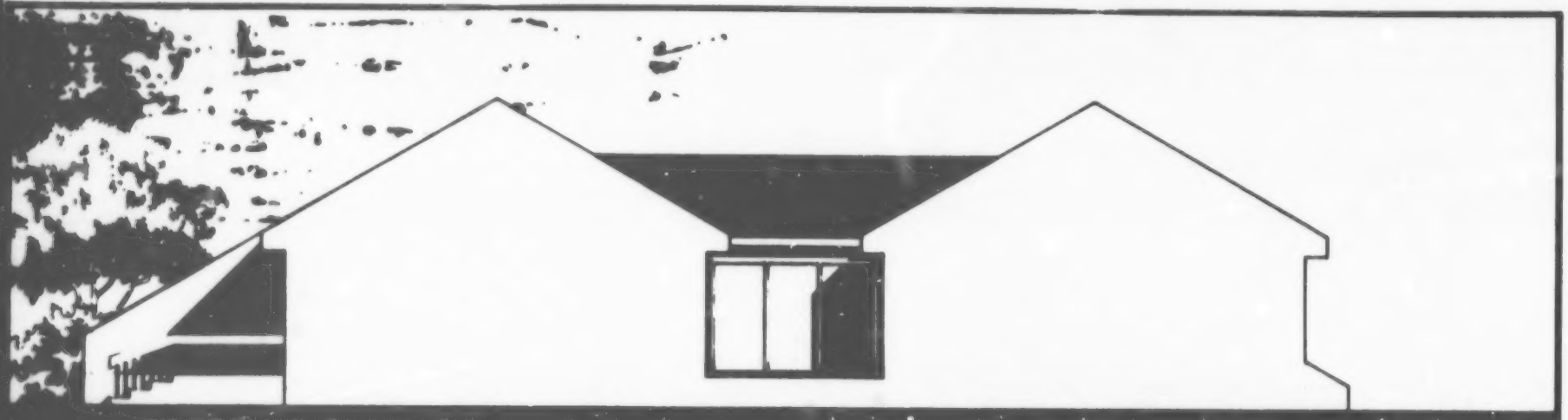


front elevation

UNIT •A•

VOLUME 2 SHEET 16

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES



side elevation

front elevation

UNIT •B•

VOLUME 2 SHEET 17

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

c. frost architects

UNIT •C•

VOLUME 2 SHEET 18

SINGLE FAMILY MODULAR HOUSING FOR RESOURCE COMMUNITIES

APPENDIX I

B. SCOPE OF WORK DOCUMENTS - ON-SITE ACCOMMODATION

The drawings illustrate the factory and site responsibilities for the construction of permanent accommodation in a remote area.

The set is abridged. It is intended to provide the reader with a concept of a different aesthetic and illustrate how the drawing system can be used to put forward contract options.

Composite Volume:

This volume, for use by the project manager or construction superintendent, illustrates the combination of modular and site built work. It is composed of drawings presented in the two volumes. In more detailed construction documents colour overlays would be added to illustrate structural, mechanical, electrical and site construction.

C:1 Site Plan
C:2 Typical Floor Plans
C:3 Dining Room Elevation (Also 2:11)
C:4 East Elevation Alternate 1 (Also 2:5)
C:5 East Elevation Alternate 2 (Also 2:6)
C:6 South Elevation (Also 2:7)
C:7 Composite Section

Factory Volume:

The factory volume would provide all information necessary for the construction of the modules and their location on site.

1:1 Typical Module
1:2 Module Location Plan (not illustrated)
1:3 Typical Room Plan
1:4 Typical Room Elevation (Alternate to 2:3)
1:5 Furnishing Layout (Alternate to 2:4)
1:6 Modular Section
1:7 Dining Room Modules (not illustrated)

Site Construction Volume:

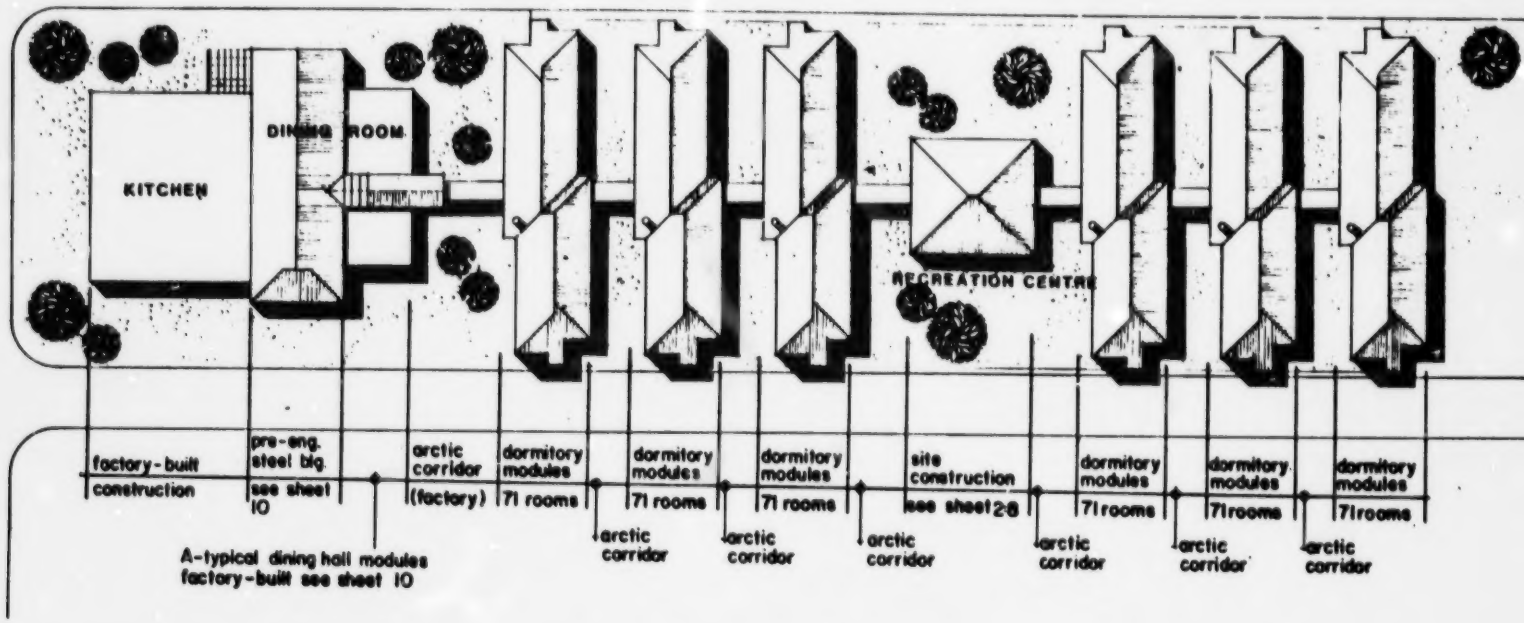
The site construction volume presented here indicates the work of subtrades following the installation of the modules. More detailed contract documents would provide foundation information and site details in separate chapters as discussed earlier.

2:1 Site Construction Alternate A
2:2 Site Construction Alternate B
2:3 Typical Room Elevation (Alternate to 1:4)
2:4 Typical Furnishing Layout (Alternate to 1:5)
2:5 East Elevation (Shown as C4)

(continued)

SCOPE OF WORK DOCUMENTS - ON-SITE ACCOMMODATION (continued)

2:6 East Elevation (Shown as C5)
2:7 South Elevation (Shown as C6)
2:8 Recreation Centre Plan
2:9 Kitchen Plan (not illustrated)
2:10 Dining Room Plan
2:11 Dining Room Elevation (Shown as C3)
2:12 Site Construction Section



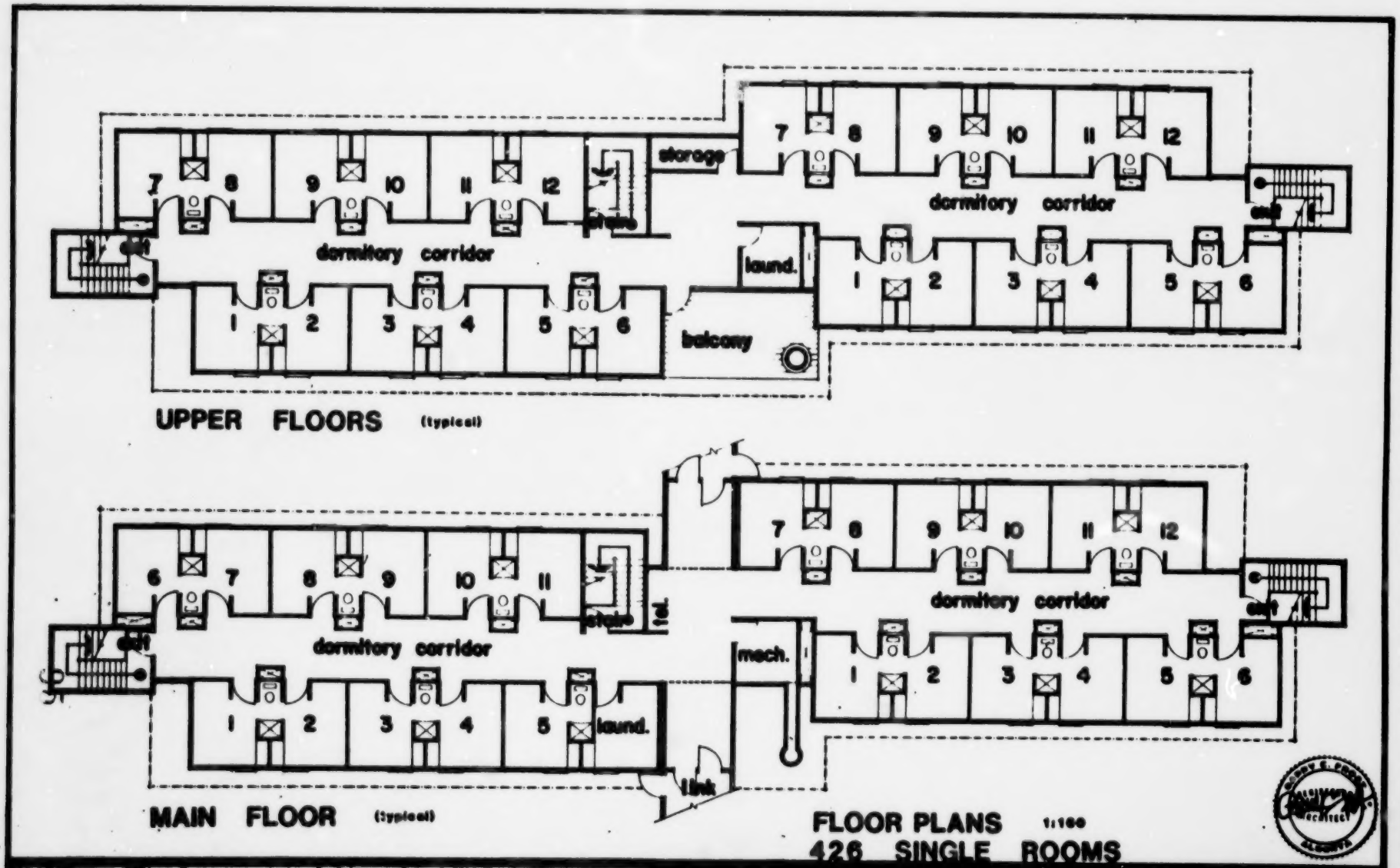
SCHEMATIC SITE PLAN
1 : 500

called north

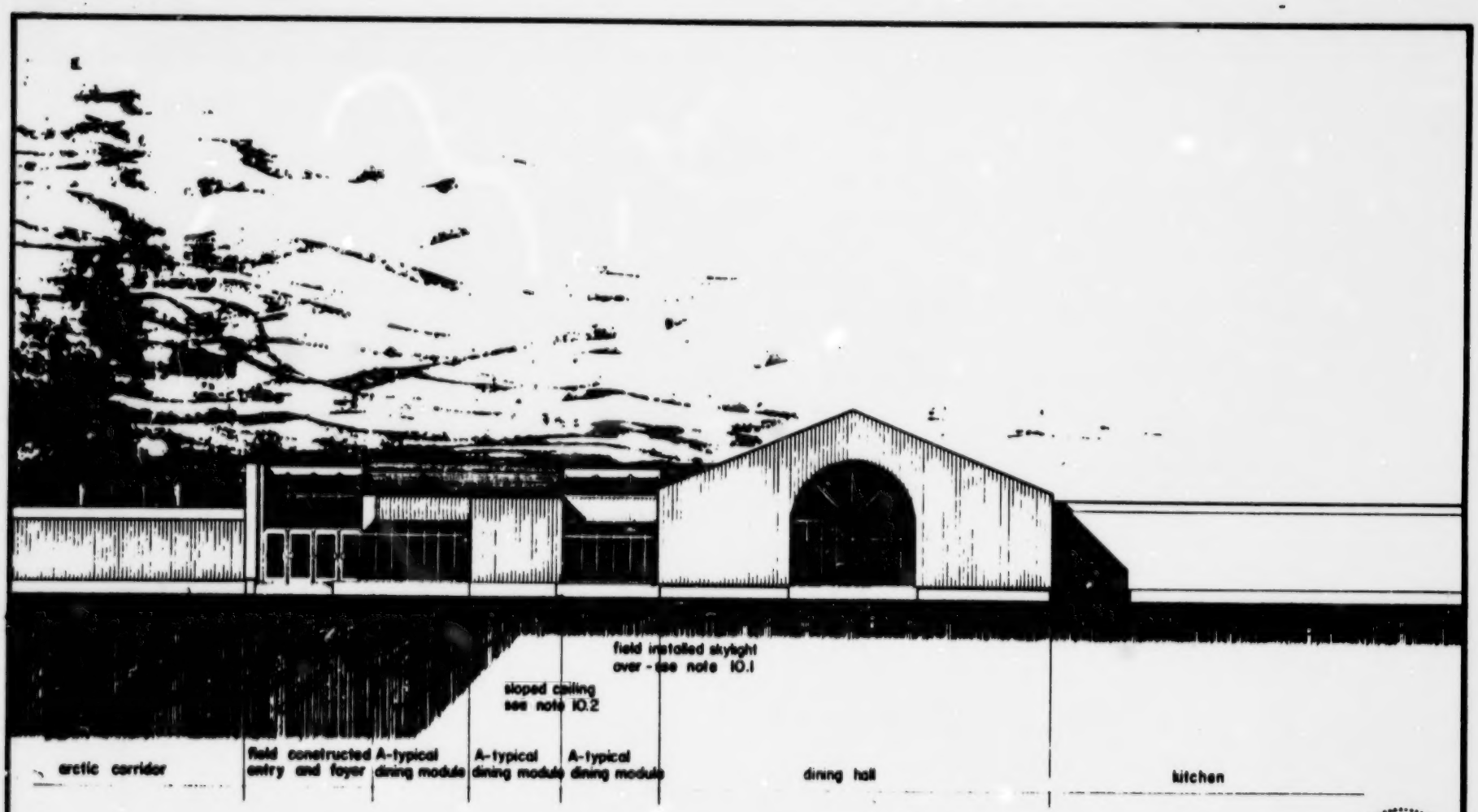
VOLUME C / 1 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)

gerry c. frost architects



WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)



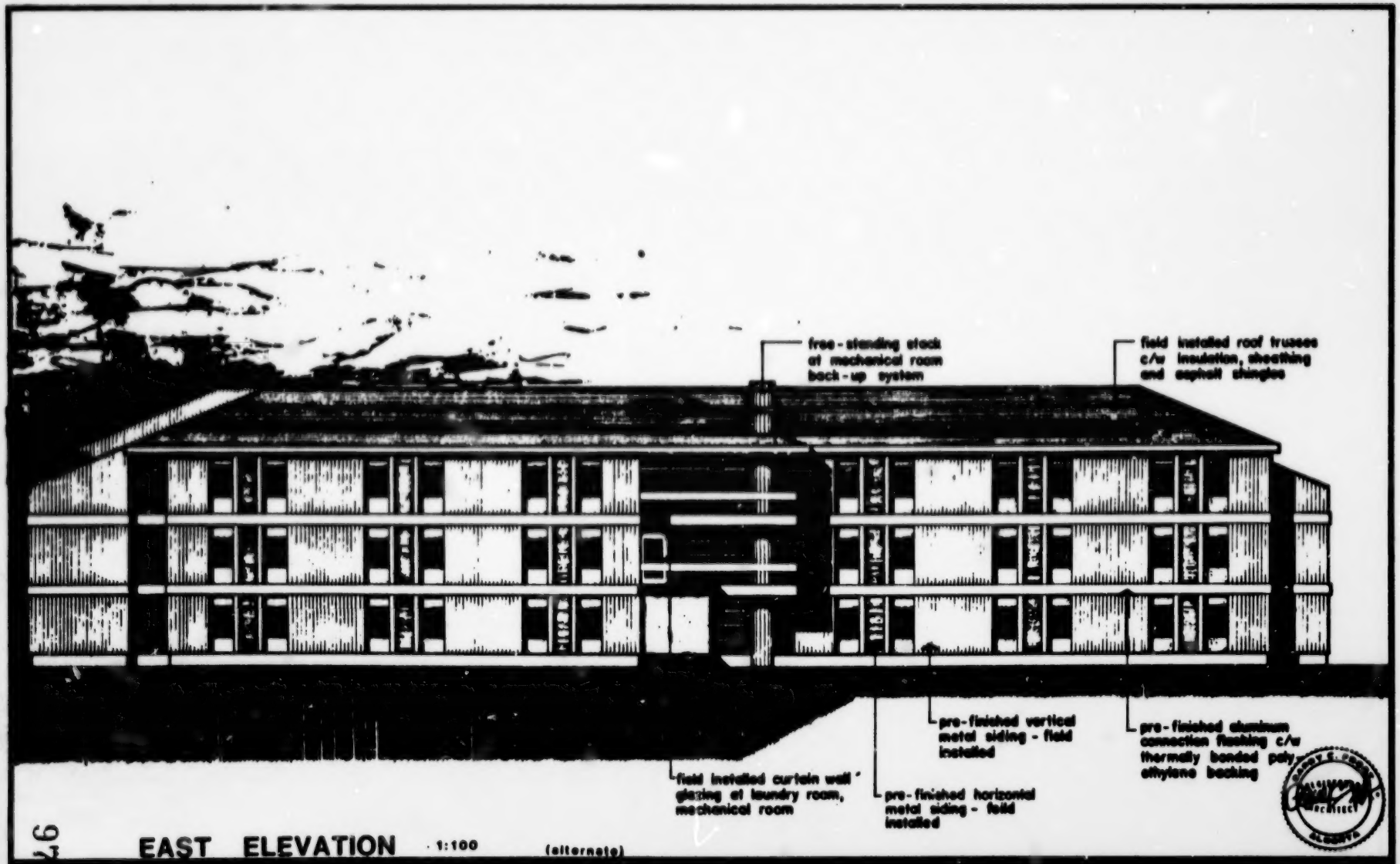
96

DINING ROOM SOUTH

VOLUME C / SHEET 3

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)

gary c frost architect ltd

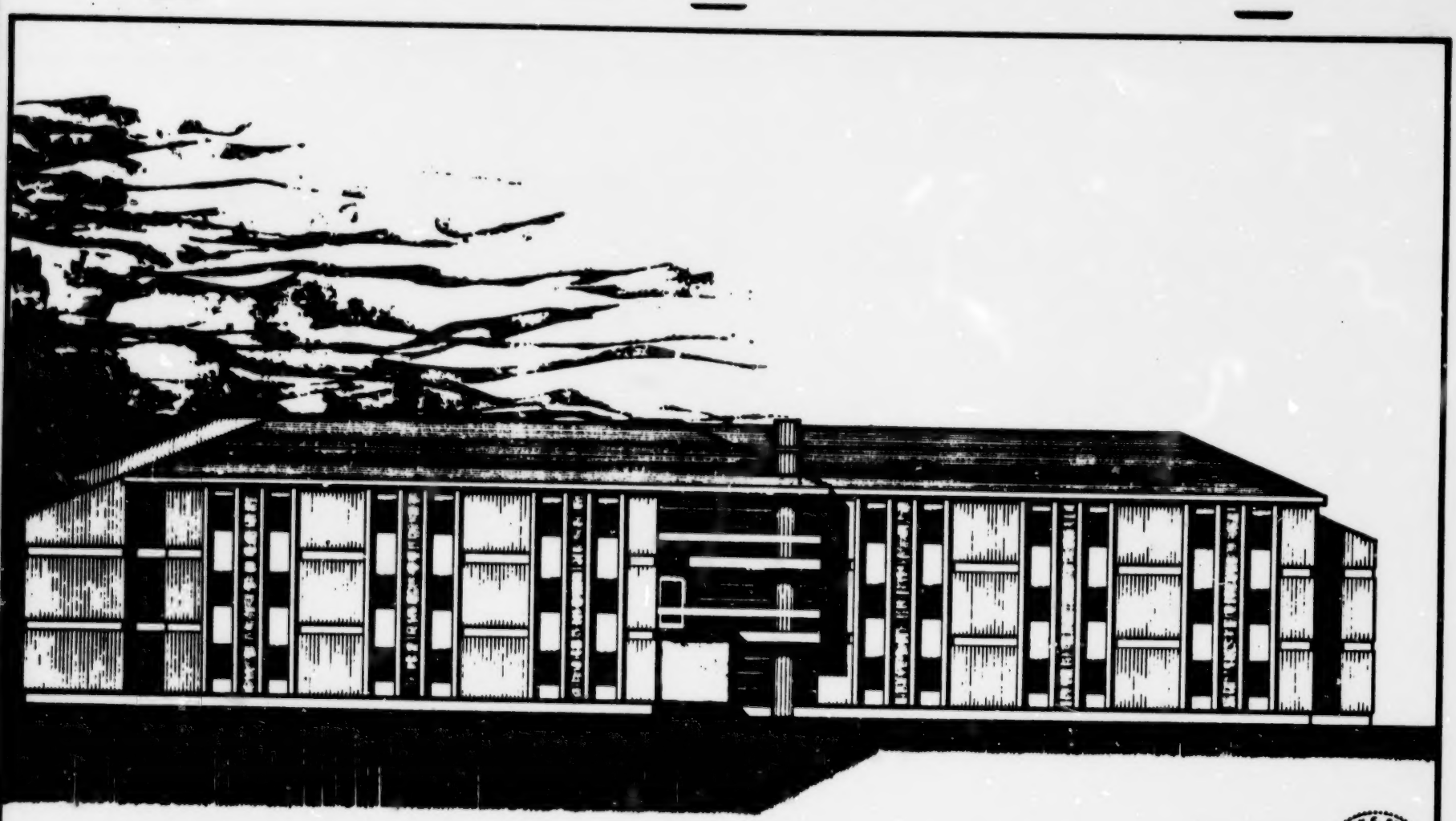

free - standing stack at mechanical room back - up system
field installed roof trusses c/w insulation, sheathing and asphalt shingles
pre - finished vertical metal siding - field installed
pre - finished aluminum connection flashing c/w thermally bonded poly ethylene backing
field installed curtain wall glazing at laundry room, mechanical room
pre - finished horizontal metal siding - field installed

EAST ELEVATION 1:100 (alternate)

VOLUME 6 SHEET 4

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)



EAST ELEVATION 1:100 (alternate)

VOLUME 6 / 5 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)

ARCTIC CORRIDOR

- factory constructed module typical
- site installed items :
  - pre-finished vertical metal siding
  - pre-finished aluminum flashing c/w thermally bonded polyethylene backing
  - skylight in aluminum frame
  - inverted roof on factory installed membrane

RECREATION CENTRE

- site construction - for floor plan see sheet 28
- pre-finished metal siding and asphalt roofing to match dormitory units

DORMITORY UNIT

end elevation

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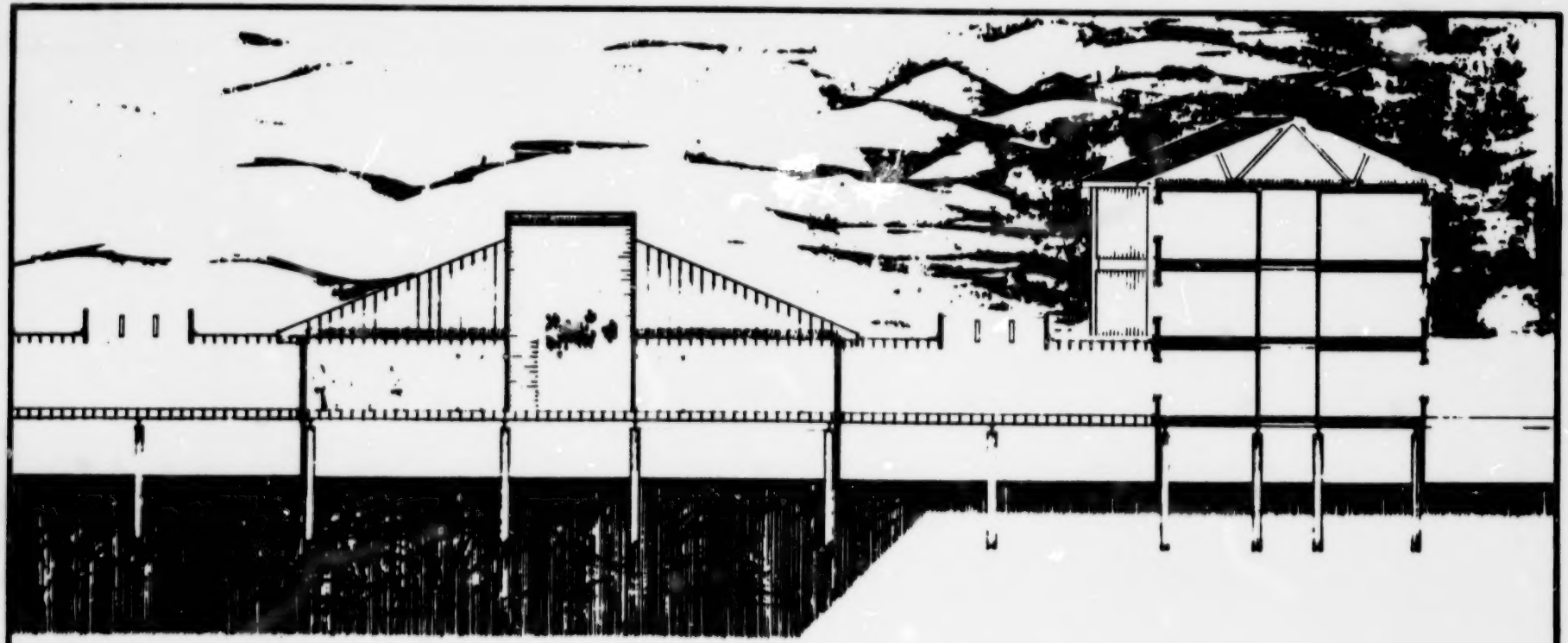
LINK RECREATION CENTRE SOUTH

VOLUME C / SHEET 6

WORKER ACCOMODATION FOR REMOTE AREAS

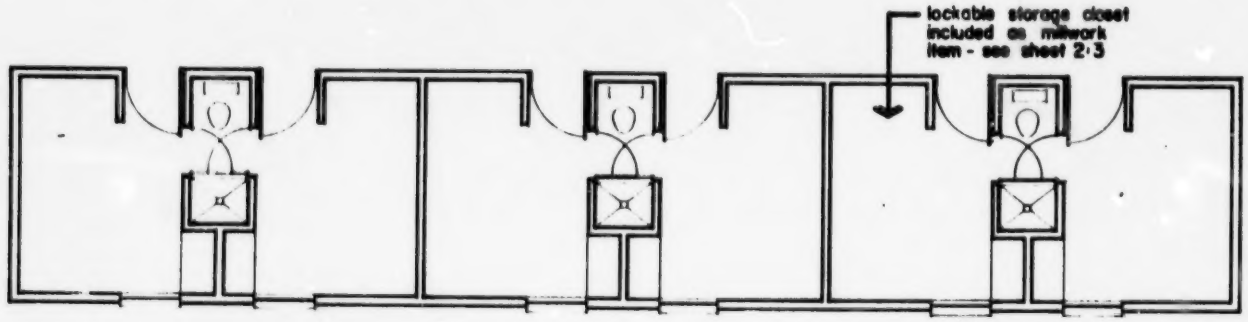
(400 UNIT MODULE expandable)



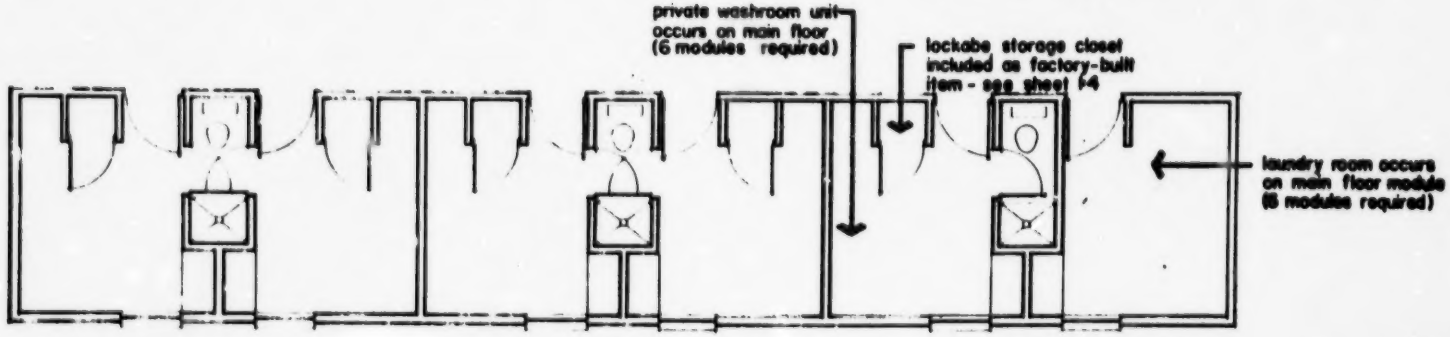
COMPOSITE SECTION

VOLUME C / 1 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)



ALTERNATE 2



ALTERNATE 1

TYPICAL MODULES 1:100

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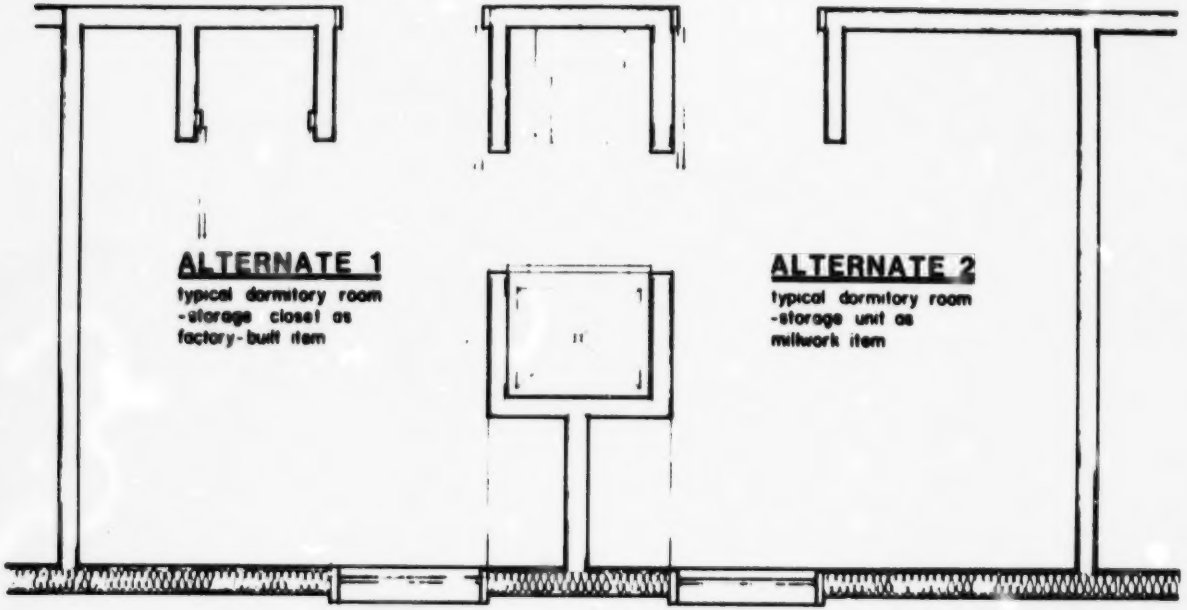
VOLUME 1 / SHEET 1

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)



TYPICAL ROOM PLAN 1:20

VOLUME 1 / 3 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)

gary c frost architect ltd

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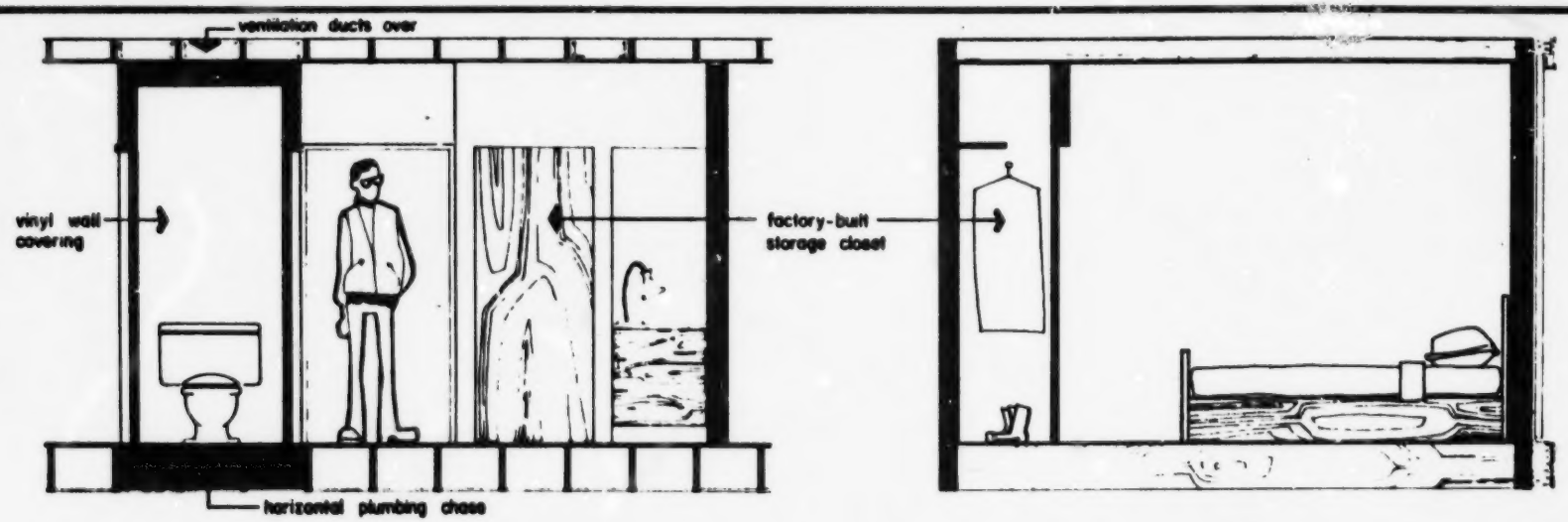
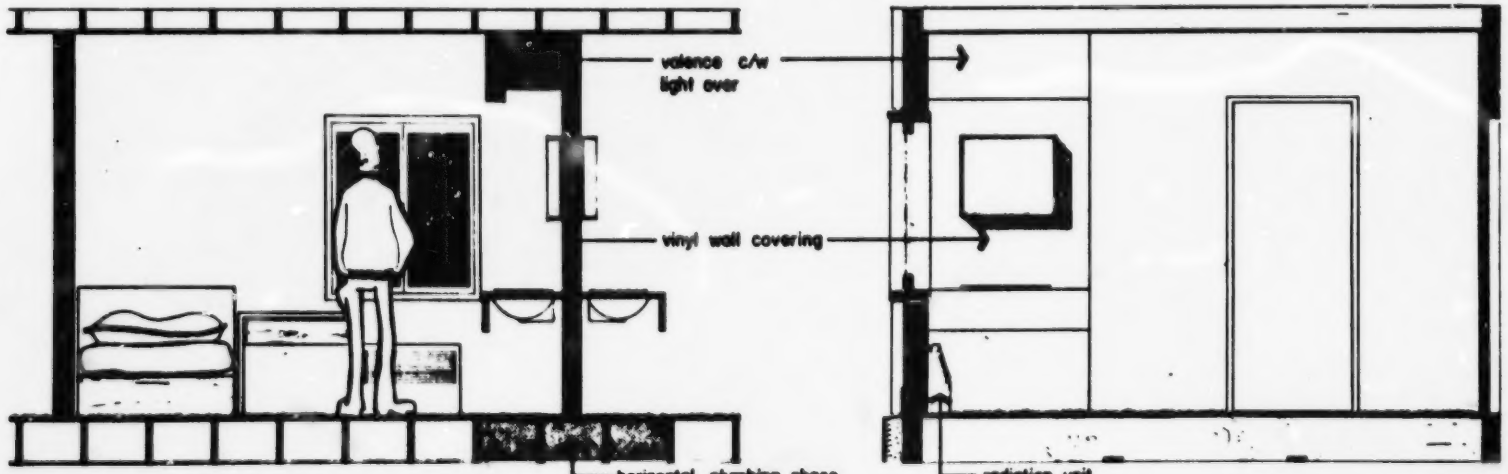


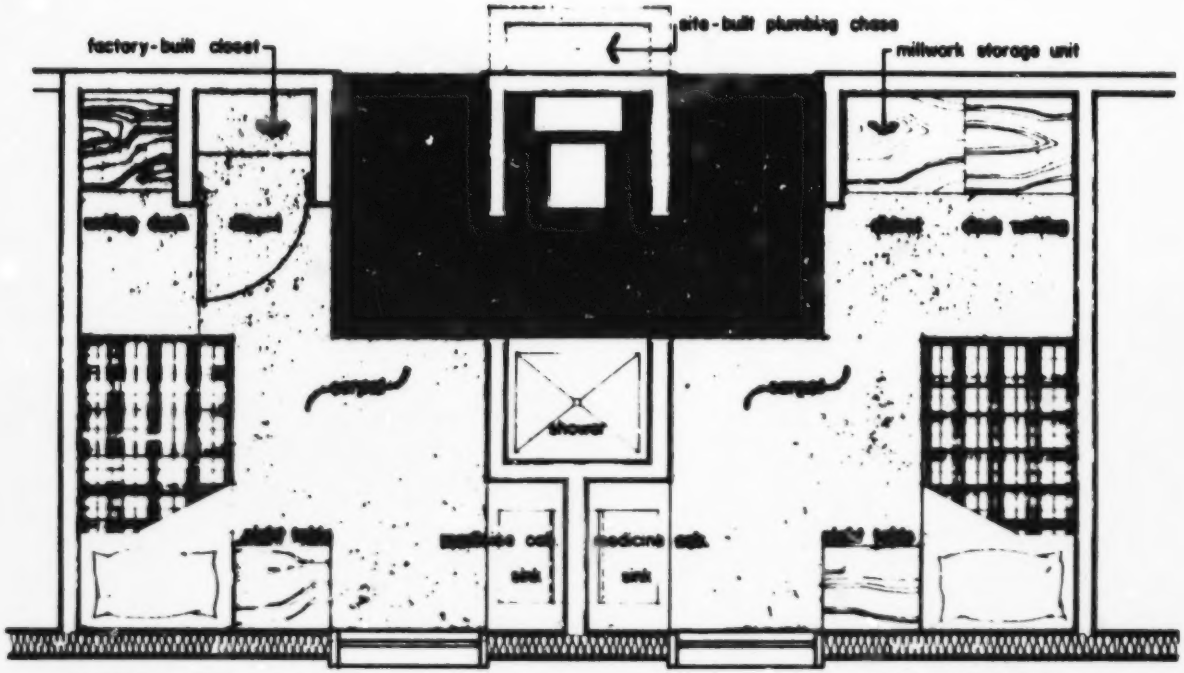


TYPICAL ROOM ELEVATION 1:20
(alternate 1)

103

VOLUME 1 / 4 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)



ALTERNATE 1
for interior elevations
see sheet 1-4

ALTERNATE 2
for interior elevations
see sheet 2-3

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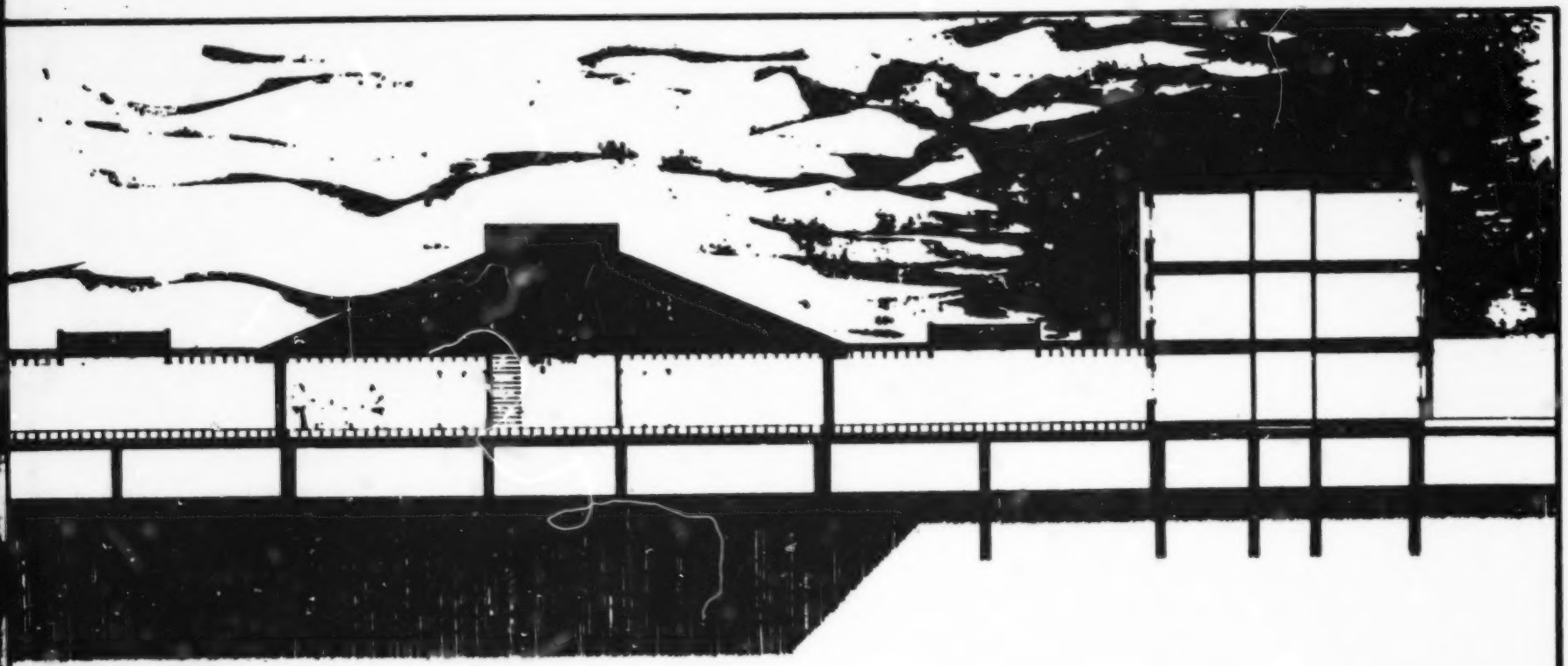
TYPICAL ROOM PLAN 1:20 FURNISHING

VOLUME 1 / 5 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)

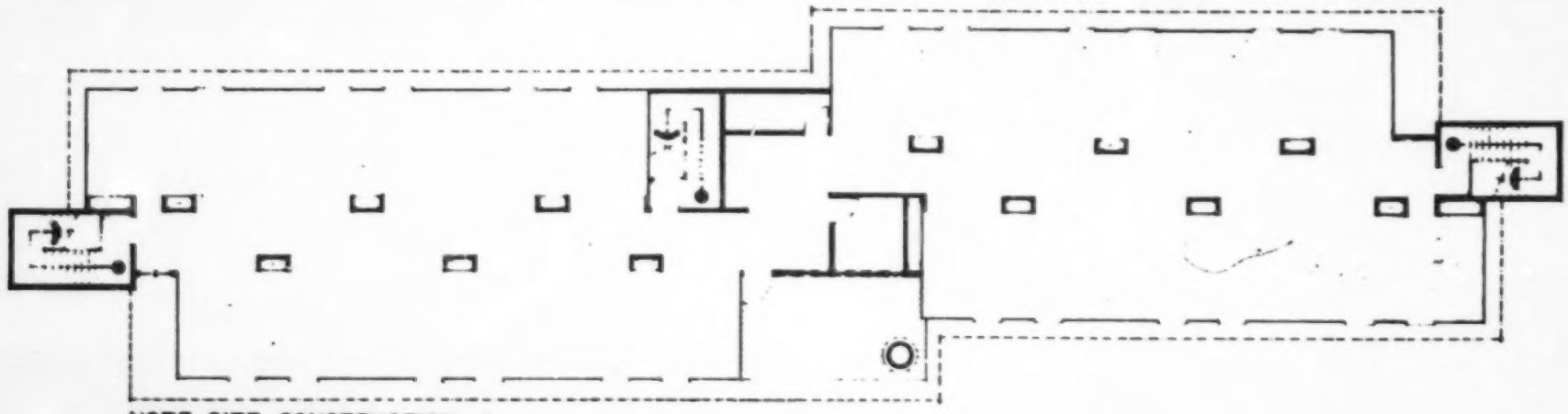
ARTHY C. FROST architect ltd



SECTION MODULAR CONSTRUCTION

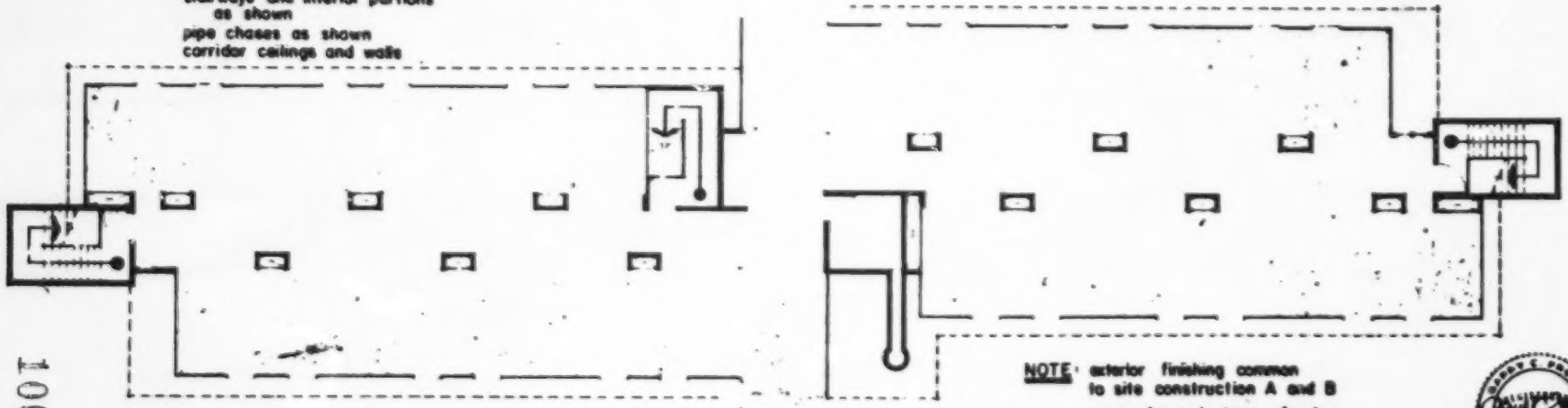
WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)



NOTE: SITE CONSTRUCTION A

INTERIOR FINISHING LIMITED TO:
- stairways and interior portions as shown
- pipe chases as shown
- corridor ceilings and walls



NOTE: exterior finishing common to site construction A and B

areas shown in tone refer to factory-built construction, black lines show site construction

GARY E. FROST Architect ALBERTA

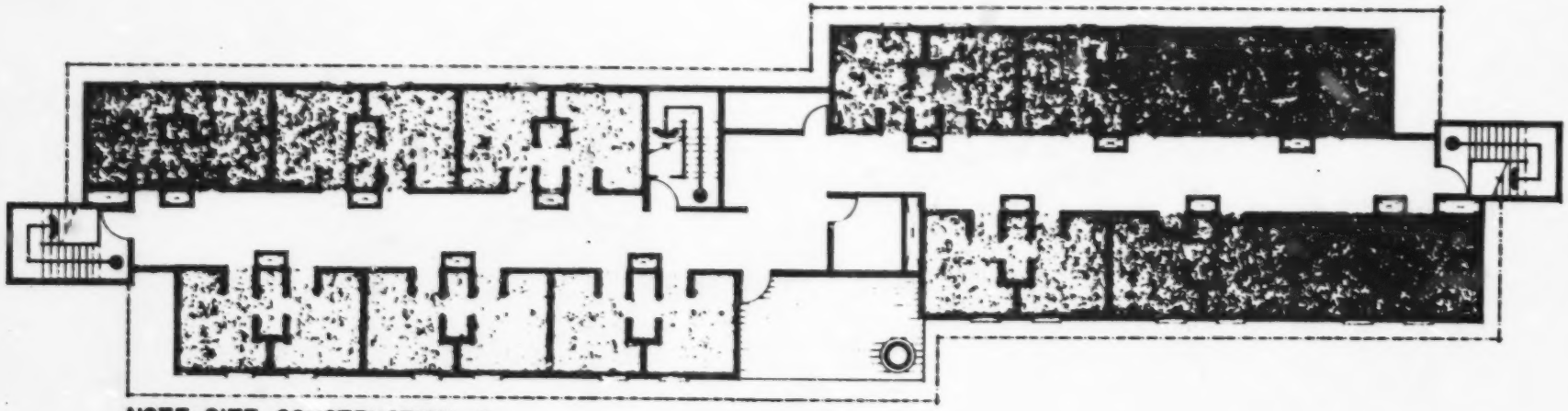
SITE CONSTRUCTION (alternate)

VOLUME 2 / 1 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS

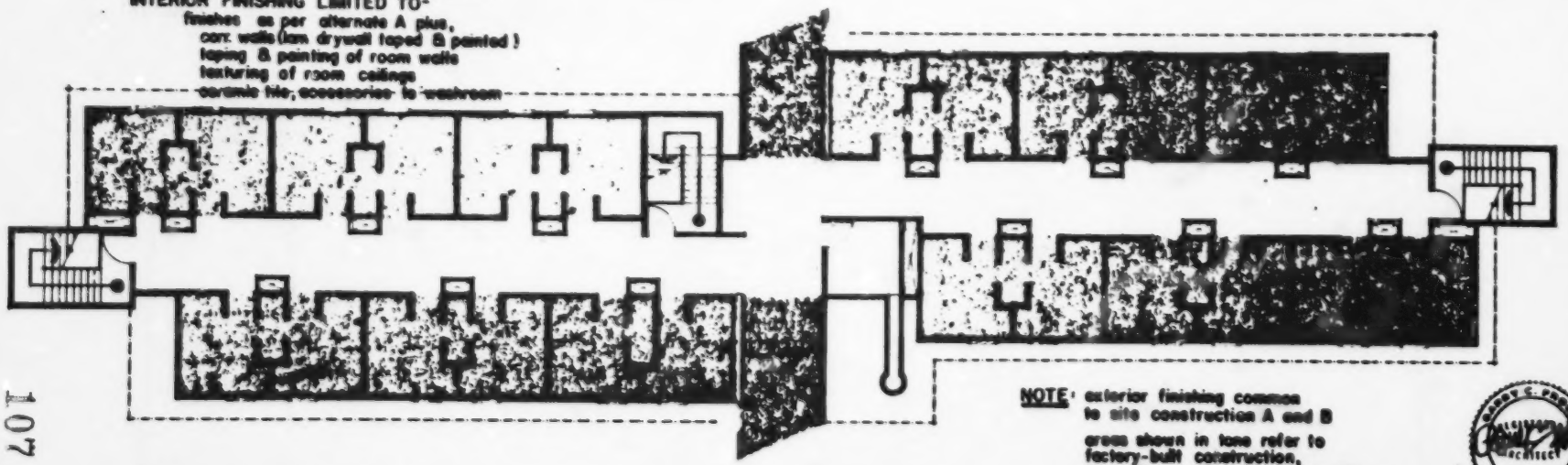
(400 UNIT MODULE expandable)

gary c frost architect ltd



NOTE: SITE CONSTRUCTION B

INTERIOR FINISHING LIMITED TO-
- finishes as per alternate A plus,
- conc. walls (1cm drywall taped & painted)
- taping & painting of room walls
- texturing of room ceilings
- ceramic tile, accessories to washroom



NOTE: exterior finishing common to site construction A and B

areas shown in tone refer to factory-built construction, black lines show site construction

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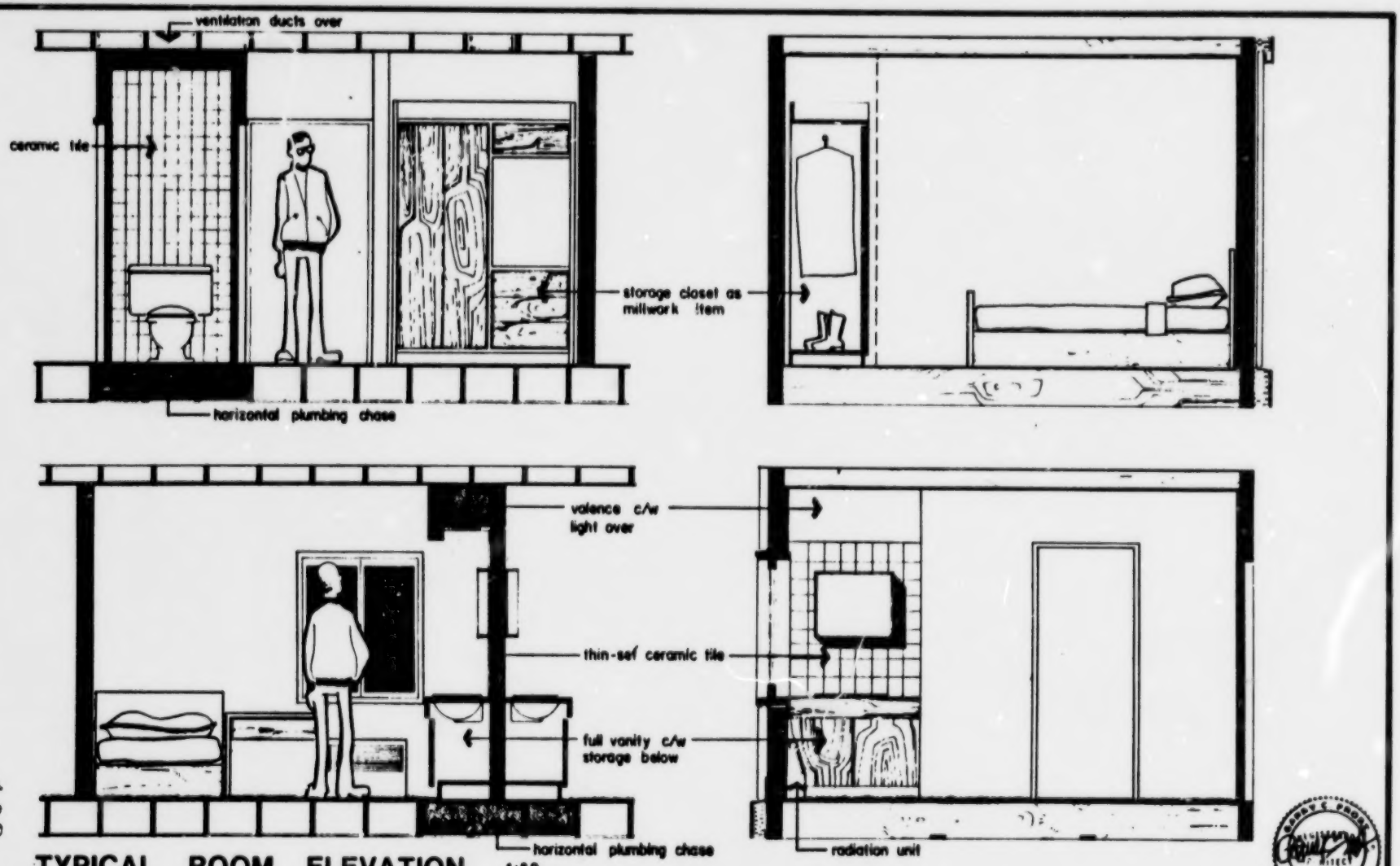
SITE CONSTRUCTION (alternate)

VOLUME 2/2 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)



TYPICAL ROOM ELEVATION 1:20
(alternate 2)

807

VOLUME 2/3 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)

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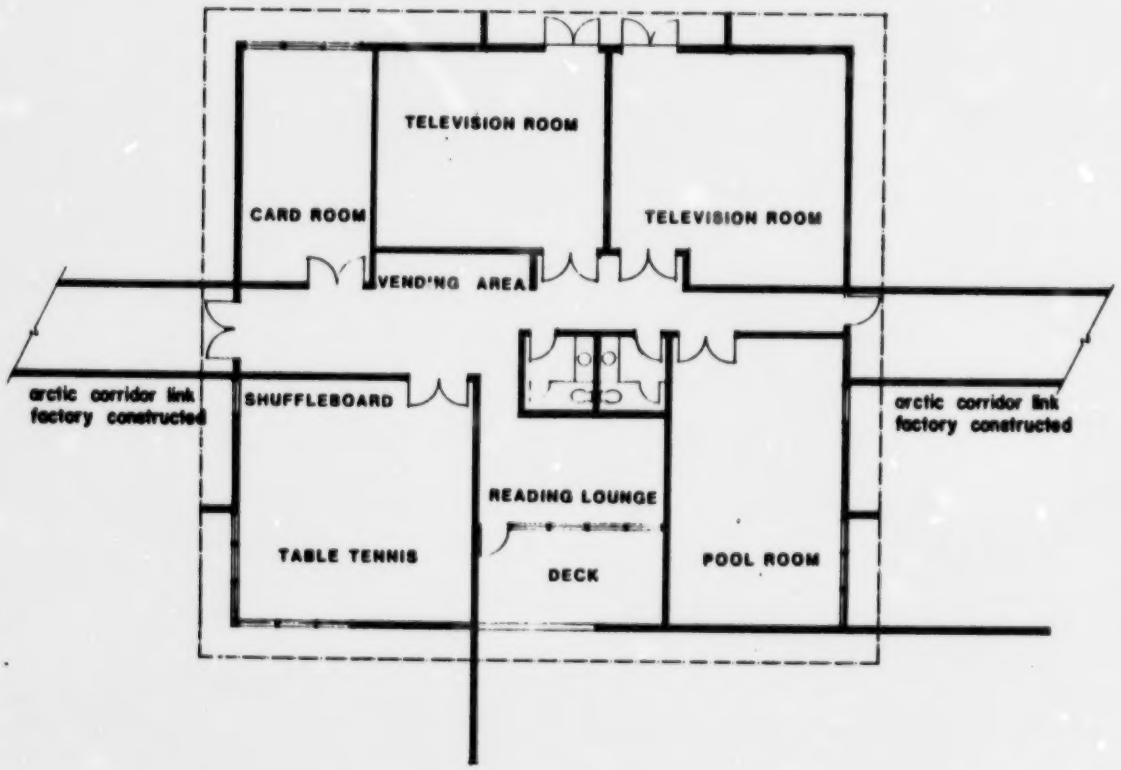

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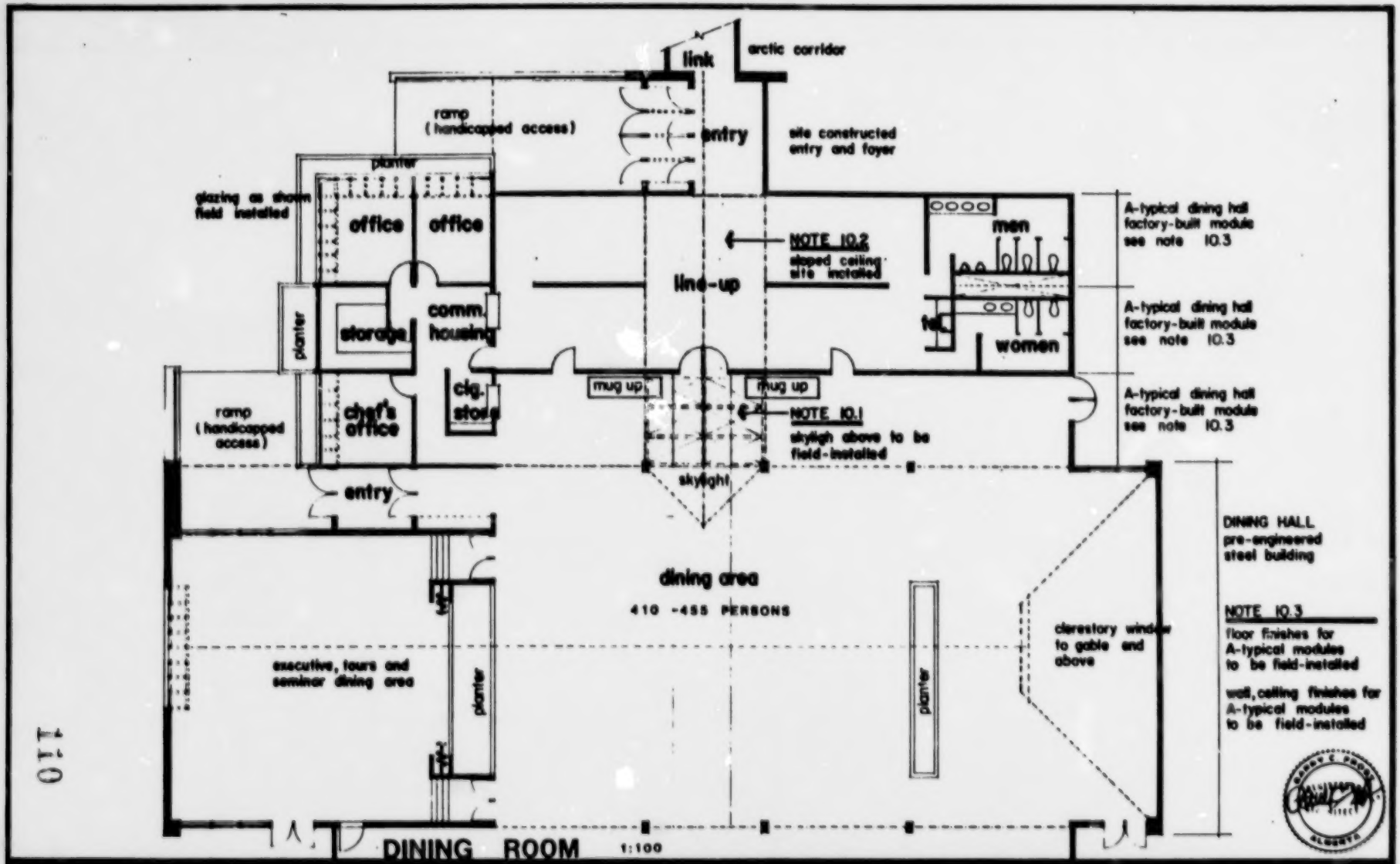
RECREATION CENTRE 1:100

VOLUME 2/8 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS
(400 UNIT MODULE expandable)



110

VOLUME 2 / 10 SHEET

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)

gary c frost architect ltd

111

SECTION SITE CONSTRUCTION

VOLUME 2 / SHEET 12

WORKER ACCOMODATION FOR REMOTE AREAS

(400 UNIT MODULE expandable)

APPENDIX II - EXPLANATION OF METHODOLOGY

The participation of resource companies and housing manufacturers was essential to development of the unit design, prices and evaluation of the potential contract processes.

Key informants provided information to each part of the project through formal and informal conversation with the research team. In the design phase, a more formal interview was undertaken to establish appropriate design criteria.

Participation in a design problem with one key informant was of particular value in developing the contract formats.